AGRICULTURAL RESEARCH INSTITUTE

PUSA

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President: LYMAN J. BRIGGS, Bureau of Plant Industry.
Corresponding Secretary: ROBERT B. SOSMAN, Geophysical Laboratory.
Recording Secretary: WILLIAM R. MAXON, National Museum.
Treasurer: R. L. FARIS, Coast and Geodetic Survey.

REPRINT OF LECTURES ON SCIENCE IN RELATION TO THE WAR

A series of public lectures dealing with the scientific and engineering aspects of the war was given under the auspices of the Washington Academy of Sciences during the winter and spring of 1918. The lectures as published in the JOURNAL are as follows:

Major S. J. M. AULD, of the British Military Mission: *Methods of gas warfare.*

Col. C. F. LEE, of the British Aviation Mission: *Aviation.*

Maj. Gen. JOHN HEADLAM, C.B., D.S.O., of the British Artillery Mission: *The development of artillery during the war.*

Lieut. Col. X. REILLE, Chief of Artillery in the French Advisory Mission: *The problem of anti-aircraft firing.*

Dr. RAYMOND PEARL, of the U. S. Food Administration: *Biology and war.*

Prof. ARTHUR A. NOYES, of the Massachusetts Institute of Technology: *The nitrogen problem in relation to the war.*

The ACADEMY has reprinted in collected form a limited edition of these lectures. Copies of the brochure, substantially bound in flexible cloth covers, may be purchased of the Treasurer, Mr. R. L. Faris, Coast and Geodetic Survey, Washington, D. C., at seventy-five cents each (postage included).

ANNOUNCEMENT OF MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES[1]

Thursday, January 9. Joint meeting of the Chemical Society and the Washington Academy of Sciences, at the Administration Building of the Carnegie Institution, 16th and P Streets, at 8.15 p.m. Program:

Address of the retiring President of the Chemical Society, DR. F. B. POWER: *The distribution and characters of some of the odorous principles of plants.* (Illustrated.)

Tuesday, January 14: The Washington Academy of Sciences, at the Administration Building of the Carnegie Institution, 16th and P Streets, at 8.15 p.m. Program:

Annual meeting for the reports of officers, announcement of elections, and other business.

Address of the retiring President of the Academy, DR. LYMAN J. BRIGGS: *The resistance of the air.* (Illustrated.)

[1] The programs of the meetings of the affiliated Societies will appear on this page if sent to the editors by the thirteenth and twenty-seventh of each month.

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Thursday, January 23. The Chemical Society, at the Cosmos Club, at 8.00 p.m. Program.

W. H. Smith: *Aeroplane dopes.* 25 minutes.

R. N. Harger: *The preparation of "metol."* 20 minutes.

J. D. Davis: *The removal of phosphine from ammonia made from cyanamide.* 15 minutes.

Saturday, January 25. The Biological Society, at the Auditorium of the New National Museum, at 8.00 p.m. Program:

G. Dallas Hanna: *Additions to the avifauna of the Pribilof Islands, including species new to North America.* Illustrated with specimens. 20 minutes.

W. L. McAtee: *An account of poisonous sumacs, ivy poisoning, and remedies therefor.* 30 minutes.

Tuesday, February 4. The Botanical Society, at the Cosmos Club, at 8.00 p.m.

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Saturday, February 8. The Biological Society, at the Cosmos Club, at 8.00 p.m. Program:

Demonstration of a new portable moving-picture machine. 15 minutes.

E. W. NELSON: Dallia pectralis, *Alaska's most remarkable fish.* 15 minutes.

VERNON BAILEY: *The western skunk cabbage in its prime.* (Illustrated.) 10 minutes.

M. W. LYON, JR.: *Iso-hemugglutin groups of men.* (With demonstration.) 20 minutes.

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Saturday, February 22. The Biological Society, at the Cosmos Club, at 8.00 p.m. Program:

Address of the retiring President, J. N ROSE: *Botanical Explorations in Equador.* (Illustrated.)

Tuesday, March 4. The Botanical Society, at the Cosmos Club, at 8.00 p.m. Program:

A. S. HITCHCOCK: *A botanical trip to the Hawaiian Islands.* (Illustrated.) 35 min.

W. E. SAFFORD: *Vegetation of Paradise Key and the surrounding Everglades.* (Illustrated.) 35 min.

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Tuesday, March 4. The Anthropological Society, at the Army Medical Museum, at 4.15 p.m. Program:

J. WALTER FEWKES: *Archeology of the Mexican oil field.* (Illustrated.)

Tuesday, March 4. The Botanical Society, at the Cosmos Club, at 8.00 p.m. Program:

A. S. HITCHCOCK: *A botanical trip to the Hawaiian Islands.* (Illustrated.) 35 min.

W. E. SAFFORD: *Vegetation of Paradise Key and the surrounding Everglades.* (Illustrated.) 35 min.

Wednesday, March 5. The Society of Engineers.

Wednesday, March 5. The Medical Society, at 8.00 p.m.

Thursday, March 6. The Entomological Society.

Saturday, March 8. The Biological Society, at the Cosmos Club, at 8.00 p.m. Program:

A Symposium on the subject: *The kind of differences that distinguish a species from a subdivision of a species.* Mammals, N. HOLLISTER; birds, H. C. OBERHOLSER; fishes, W. C. KENDALL; insects, A. N. CAUDELL; mollusks, P. BARTSCH; botany, C. V. PIPER, S. F. BLAKE. 10 min. each.

Wednesday, March 11. The Electrical Engineers.

Thursday, March 12. The Geological Society, at the Cosmos Club, at 8.00 p.m. Program:

F. E. MATTHES: *The graphic representation of topographic forms.*
R. B. SOSMAN: *Note on volcanic explosions.*

Thursday, March 12. The Medical Society.

Friday, March 13. The Chemical Society, at the Cosmos Club, at 8.00 p.m. Program:

Lieut. Col ARTHUR B. LAMB, Chemical Warfare Service: *Chemical protection against poisonous gases.*

Saturday, March 15. Joint meeting of the Washington Academy of Sciences and the Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

DR. H. D. CURTIS, Lick Observatory: *Modern theories of spiral nebulae.*

Tuesday, March 18. The Anthropological Society.

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Wednesday, March 19. The Society of Engineers.

Wednesday, March 19. The Medical Society.

Thursday, March 20. The Washington Academy of Sciences, at the Cosmos Club, at 8.15 p. m. Program:

Lieut. Col. JOHN R. MURLIN, U. S. A.: *Food efficiency in the United States Army.*

Thursday, March 20. The Society of Foresters, at the Wilson Normal School, at 8.15 p.m. Program:

Forestry in the Southern Appalachians:

WILLIAM L. HALL: *Influence of government ownership.*

W. W. ASHE: *Effect of changed conditions upon forestry.*

F. W. REED: *Progress in silvicultural practice.*

Saturday, March 22. The Biological Society, at the Cosmos Club, at 8.00 p.m.

Wednesday, March 26. The Medical Society.

Wednesday, March 26. The Geological Society, at the Cosmos Club, at 8.00 p.m. Program:

R. B. SOSMAN: *Note on volcanic explosions.*

E. O. ULRICH: *Newly discovered evidence of oscillating seas of the Paleozoic era.*

Thursday, March 27. Joint meeting of the Washington Academy of Sciences and the Chemical Society, at the Cosmos Club, at 8.15 p.m. Program:

ARTHUR L. DAY: *Optical glass.*

Saturday, March 29. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

W. R. GREGG: *Trans-Atlantic flight from the meteorologist's point of view.* (Illustrated.) 40 min.

C. F. MARVIN: *The flight of aircraft and the deflective influence of the earth's rotation.* 15 min.

Tuesday, April 1. The Anthropological Society.

Wednesday, April 2. The Society of Engineers.

Wednesday, April 2. The Medical Society.

Thursday, April 3. The Entomological Society.

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Friday, April 4. The Washington Academy of Sciences, at the Cosmos Club, at 8.15 p.m. Program:

Lieut Col. Byron C. Goss, Chief Gas Officer, Second Army, A. E. F.: *Gas warfare at the front.*

Saturday, April 5. The Biological Society, at the Cosmos Club, at 8.00 p.m. Program:

W. P. Taylor: *Notes on Dr. James Graham Cooper's scientific investigations on the Pacific Coast.* 10 min.

Alexander Wetmore: *The brown pelican.* (Illustrated.) 20 min.

Agnes Chase: *The oil grasses and their uses in perfumery.* 15 min

Tuesday, April 8. The Electrical Engineers.

Wednesday, April 9. The Geological Society, at the Cosmos Club, at 8.00 p.m. Program:

C. E. Van Ostrand: *Temperatures in some deep wells in the United States.*

E. T. Wherry: *Some practical applications of crystallography.*

E. W. Berry: *Present tendencies in geology. I. Paleontology.*

Wednesday, April 9. The Medical Society.

Saturday, April 12. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

William Bowie: *Mapping the United States for military and civil needs.* (Illustrated.) 30 min.

Oscar S. Adams: *A study of map projections in general.* (Illustrated.) 30 min.

Tuesday, April 15. The Chemical Society, at the Cosmos Club, at 8.00 p.m. Program:

Reports from the Buffalo Meeting of the American Chemical Society.

Tuesday, April 15. The Anthropological Society.

Wednesday, April 16. The Society of Engineers.

Saturday, April 19. The Biological Society, at the Cosmos Club, at 8.00 p.m.

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Saturday, April 19. The Biological Society, at the Cosmos Club, at 8.00 p.m.

Wednesday, April 23. The Medical Society.

Wednesday, April 23. The Geological Society.

Thursday, April 24. The Chemical Society.

Friday and Saturday, April 25 and 26. Ninety-seventh regular meeting of the American Physical Society at the Bureau of Standards. Exhibit of physical apparatus illustrating the application of physical principles to the solution of war problems.

Monday, April 28 The Board of Managers of the Washington Academy of Sciences.

Wednesday, April 30. The Medical Society.

Thursday, May 1. The Entomological Society.

Saturday, May 3. The Biological Society.

Saturday, May 10. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

F. J. Schlink; *On the nature of the inherent variability of measuring instruments.* (Illustrated.) 30 min.

R. L Sanford: *Magnetic analysis.* (Illustrated.) 30 min.

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ANNOUNCEMENT OF MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

Tuesday, May 6. The Botanical Society.

Wednesday, May 7. The Medical Society.

Thursday, May 8. The Chemical Society.

Saturday, May 10. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

F. J. Schlink: *On the nature of the inherent variability of measuring instruments.* (Illustrated.) 30 min.

R. L. Sanford: *Magnetic analysis.* (Illustrated.) 30 min.

Tuesday, May 13. Electrical Engineers.

Wednesday, May 14. The Geological Society.

Wednesday, May 14. The Medical Society.

Thursday, May 15. The Washington Academy of Sciences.

Saturday, May 17. The Biological Society.

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ANNOUNCEMENT OF MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

Tuesday, May 20. The Historical Society.

Wednesday, May 21. The Medical Society.

Thursday, May 22. The Chemical Society, at the Cosmos Club, at 8.15 p.m. Program:

H. D. GIBBS: *The work of the Color Laboratory of the Bureau of Chemistry.*

K. P. MONROE: *The commercial preparation and utilization of the enzyme invertase.*

Saturday, May 24. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

H. L. CURTIS and R. C. DUNCAN: *Measurement of short time intervals.* (Illustrated.) 20 minutes.

A. F. BEAL: *Comparison of invar with steel as shown by the rates of high grade watches.* (Illustrated.) 40 minutes.

Monday, May 26. Board of Managers, Washington Academy of Sciences.

Tuesday, May 27. The Washington Academy of Sciences, at the Cosmos Club, at 8.15 p.m. Program:

A. O. LEUSCHNER: *The determination of the orbits of comets and planets.*

Wednesday, May 28. The Medical Society.

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ANNOUNCEMENT OF MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

Thursday, June 5. The Entomological Society.

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ANNOUNCEMENT OF MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES[1]

Thursday, October 2. The Entomological Society, at the Cosmos Club, at 8 p.m.

[1]The programs of the meetings of the affiliated societies will appear on this page if sent to the Editor by the thirteenth and twenty-seventh of the month.

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ANNOUNCEMENT OF MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES[1]

Tuesday, October 7. The Anthropological Society, at Room 43, National Museum, at 4.30 p.m.

Tuesday, October 7. The Botanical Society, at the Cosmos Club, at 8.00 p.m. Program:

JOHN A. STEVENSON: *Some botanical aspects of Porto Rico.*

The annual meeting for the election of officers and transaction of other business will be called immediately at the close of the meeting

Thursday, October 9. The Chemical Society, at the Cosmos Club, at 8.00 p.m. Program:

E. K. NELSON: *Vanillyl acyl amides.*

C. O. JOHNS and A. J. FINKS: *Growth experiments with the proteins of the navy bean.*

W. M. CLARK and HARPER S. ZOLLER: *Manufacture of commercial casein.*

Saturday, October 11. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

C. G. ABBOT: *Solar studies in South America.* (Illustrated.) 30 minutes.

L. A. BAUER: *The total solar eclipse at Cape Palmas, Liberia, May 29, 1919.* (Illustrated.) 30 minutes

D. M. WISE: *The total solar eclipse at Sobral, Brazil, May 29, 1919.* (Illustrated.) 10 minutes.

Saturday, October 18. The Biological Society, at the Cosmos Club, at 8.00 p.m.

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ANNOUNCEMENT OF MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES[1]

Tuesday, October 21. The Anthropological Society, at Room 43, New National Museum, at 4.45 p.m. Program:

J. W. Fewkes, J. P. Harrington, J. N. B. Hewitt, W. Hough, A. Hrdlička, N. M. Judd, F. LaFlesche, T. Michelson, J. R. Swanton: *Field experiences (results of anthropological field work during the past year).*

Thursday, October 23. The Chemical Society, at the Cosmos Club, at 8.00 p.m. Program:

Charles L. Reese, of E. I. du Pont de Nemours and Co.: *The status and prospects of the dye industry in the United States.*

Saturday, October 25. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

J. H. Dellinger: *Principles of radio transmission and reception with antenna and coil aerials.* (Illustrated.)

F. L. Mohler, Paul D. Foote, and H. F. Stimson: *Ionization and resonance potentials for electrons in vapors of lead and calcium.* (Illustrated.)

Saturday, November 1. The Biological Society, at the Cosmos Club, at 8.00 p.m.

Anniversary Meeting (600th meeting).

Saturday, November 1. The Chemical Society. 9.10 a.m., Excursion to Edgewood Arsenal.

Tuesday, November 4. The Anthropological Society, at Room 43, New National Museum, at 4.45 p.m. Program:

Continuation of the reports on *Field experiences.*

Tuesday, November 4. The Botanical Society, at the Cosmos Club, at 8.00 p.m.

A. D. Cockayne, of the Department of Agriculture of New Zealand, will lecture on the vegetation of New Zealand.

Thursday, November 6. The Entomological Society, at the Cosmos Club, at 8.00 p.m.

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Tuesday, November 4. The Anthropological Society, at Room 43, New National Museum, at 4.45 p.m. Program:

Continuation of the reports on *Field experiences*.

Tuesday, November 4. The Botanical Society, at the Cosmos Club, at 8.00 p.m. Program:

A. D. COCKAYNE, of the Department of Agriculture of New Zealand, will lecture on the vegetation of New Zealand.

Wednesday, November 5. The Society of Engineers, at the Cosmos Club, at 8.15 p.m.

Thursday, November 6. The Entomological Society, at the Cosmos Club, at 8.00 p.m. Program:

Notes and exhibition of specimens.

L. O. HOWARD: *On entomologists.*

Saturday, November 8. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

R. W. G. WYCKOFF. *The nature of the forces between atoms in solids.*

H. L. CURTIS, R. C. DUNCAN AND H. H. MOORE: *Methods of measuring ballistic phenomena on a battleship.*

Tuesday, November 11. The Institute of Electrical Engineers, at the Cosmos Club, at 8.00 p.m.

Wednesday, November 12. The Geological Society, at the Cosmos Club, at 8.00 p.m.

Thursday, November 13. The Chemical Society, at the Cosmos Club, at 8.00 p.m. Program:

Annual election of officers.

E. T. WHERRY: *Crystallography in the service of the chemist.*

Saturday, November 15. The Biological Society, at the Cosmos Club, at 8.00 p.m.

Tuesday, November 18. The Anthropological Society, at Room 43, New National Museum, at 4.45 p.m.

Wednesday, November 19. The Society of Engineers, at the Cosmos Club, at 8.15 p.m.

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ANNOUNCEMENT OF MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES[1]

Wednesday, November 19. The Society of Engineers, at the National Museum, at 8.15 p.m. Program:

General discussion on preliminary report of Engineering Council's Committee on Classification and Compensation of Government Engineers, led by JOHN C. HOYT.

Saturday, November 22. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

R. C. TOLMAN *A conception of the business of mathematical physics.*

C. W. WAIDNER, E. F. MUELLER and P. D. FOOTE *The standard scale of temperature.*

Tuesday, November 25. The Scientific-Technical Section of the Federal Employees' Union, at the National Museum, at 8.15 p.m. Program:

IRVING FISHER: *The purchasing power of salaries.*

Wednesday, November 26. The Geological Society, at the Cosmos Club, at 8.00 p.m.

Saturday, November 29. The Biological Society, at the Cosmos Club, at 8.00 p.m.

Tuesday, December 2. The Anthropological Society, at Room 43, New National Museum, at 4.45 p.m.

Tuesday, December 2. The Botanical Society, at the Cosmos Club, at 8.00 p.m.

Wednesday, December 3. The Society of Engineers, at Rauscher's. Annual Banquet.

Thursday, December 4. The Entomological Society, at the Cosmos Club, at 8.00 p.m.

Saturday, December 6. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

Annual meeting for reports and election of officers.

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ANNOUNCEMENT OF MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES[1]

Thursday, December 4. The Entomological Society, at the Cosmos Club, at 8.00 p.m. Program:

Election of officers for 1920.
Wm. Schaus: *Collecting in the American Tropics.*
Notes and exhibition of specimens.

Saturday, December 6. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

Annual meeting for reports and election of officers.

Tuesday, December 9. The Institute of Electrical Engineers, at the Cosmos Club, at 8.00 p.m.

Wednesday, December 10. The Geological Society, at the Cosmos Club, at 8.00 p.m. Program:

Annual meeting for election of officers and presidential address.

Thursday, December 11. The Chemical Society, at the Cosmos Club, at 8.00 p.m.

Saturday, December 13. The Biological Society, at the Cosmos Club, at 8.00 p.m.

Tuesday, December 16. The Anthropological Society, at Room 43, New National Museum, at 4.45 p.m.

Wednesday, December 17. The Society of Engineers, at the Cosmos Club, at 8.15 p.m.

Annual meeting.

Saturday, December 20. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

J. Warren Smith: *Predicting minimum temperatures.* (Illustrated.)
Charles F. Brooks: *Clouds and their significance.* (Illustrated.)

Prospective members of the American Meteorological Society are invited to be present. At the close of the program there will be a short business meeting to discuss organization plans and to nominate officers for that society.

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ANNOUNCEMENT OF MEETINGS OF THE ACADEMY AND AFFILIATED SOCIETIES[1]

Saturday, December 20. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

J. WARREN SMITH: *Predicting minimum temperatures.* (Illustrated.)
CHARLES F. BROOKS: *Clouds and their significance.* (Illustrated.)

Prospective members of the American Meteorological Society are invited to be present. At the close of the program there will be a short business meeting to discuss organization plans and to nominate officers for that society.

Saturday, January 3. The Philosophical Society, at the Cosmos Club, at 8.15 p.m. Program:

ENOCH KARRER: I. *Diffusion of light in a searchlight beam* (Illustrated.) II. *The contrast sensibility of the eye at low illuminations.* (Illustrated.)

FRED. E. WRIGHT: *The contrast sensibility of the eye as a factor in the resolving power of the microscope.*

L. A. BAUER: *The solar eclipse of May 29, 1919, and the Einstein effect.* (Illustrated.)

Tuesday, January 6. The Anthropological Society, at Room 43, New National Museum, at 4.45 p.m.

Tuesday, January 6. The Botanical Society, at the Cosmos Club, at 8.00 p.m.

Wednesday, January 7. The Society of Engineers, at the Cosmos Club, at 8.15 p.m.

Thursday, January 8. The Chemical Society, at the Cosmos Club, at 8.00 p.m.

[1] The programs of the meetings of the affiliated societies will appear on this page if sent to the Editors by the thirteenth and twenty-seventh of the month.

// JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 9 JANUARY 4, 1919 No. 1

PALEONTOLOGY.—*On some Tertiary fossils from the Pribilof Islands.*[1] WILLIAM H. DALL, U. S. National Museum.

In 1899 I enumerated the fossils found at Black Bluff, St. Paul Island, Bering Sea, Alaska.[2] They occur at this place in fragments of sedimentary rock torn from the ocean bed and upheaved with their enclosing lava above the sea level. Mr. G. Dallas Hanna, of the U. S. Bureau of Fisheries, who has been stationed on the island for a number of years, reports that the Black Bluff locality is now entirely exhausted of its fossils. However, this loss is more than made up for by the discovery of two new localities, one on St. Paul and one on St. George Island. Curiously enough the locality on each island is locally known as Tolstoi Point, the Russian word Tolstoi meaning "broad" being used geographically in numberless localities in Alaska.

The collection is of interest as linking up the age of the strata from which these fragments were derived with the beach deposits at Nome which are referred to the late Pliocene.

In Mr. Hanna's collection are 47 species of which 44 are mollusks, 31 gastropods and 13 bivalves.

The St. Paul collection has only seven species, all found on both islands and also found at Black Bluff, so they are possibly of the same age as the Black Bluff series. Of the St. George

[1] Published with the permission of the Director of the U. S. Geological Survey.

[2] The Fur Seals and Fur Seal Islands of the North Pacific Ocean, part III. Pp. 546. Government Printing Office. 1899.

TABLE I

FOSSILS COLLECTED BY MR. G. DALLAS HANNA FROM SEDIMENTARY INCLUSIONS IN THE VOLCANIC ROCKS OF ST. PAUL AND ST. GEORGE ISLANDS, BERING SEA.

Admete sp. aff. A. middendorffiana Dall	G[a]
Chrysodomus pribiloffensis Dall	P
Chrysodomus saturus Martyn	P
Chrysodomus saturus tabularis Dall	G
Chrysodomus solutus Hermann	P G
Chrysodomus solutus elatior Middendorff	P G
Chrysodomus solutus cordatus Dall n. var.	G
Chrysodomus borealis Philippi	P G
Colus sp. n.	G
Colus sp. indet.	G
Colus sp. indet.	G
Colus sp. indet.	G
Colus sp. indet.	G
Plicifusus sp. indet.	G
Plicifusus arcticus Philippi	G
Volutopsius sp. aff. malleatus Dall	G
Volutopsius sp. aff. regularis Dall	G
Pyrulofusus sp. aff. harpa Mörch (dextral)	G
Pyrulofusus sp. aff. deformis Gray (sinistral)	G
Buccinum glaciale parallelum Dall	G
Buccinum tenue Gray	G
Buccinum sp. indet.	G
Boreoscala greenlandica Perry	G
Argobuccinum oregonense Redfield	G
Trichotropis n. sp.	G
Iphinoë kroyeri Philippi	G
Tachyrhynchus n. sp.	G
Natica clausa Broderip & Sowerby	G
Natica aleutica Dall	G
Velutina laevigata Pennant	G
Cingula robusta Dall	G
Pecten (Chlamys) islandicus beringianus Middendorff	G
Thracia curta Conrad	G
Astarte actis Dall	G
Astarte sp. indet.	G
Astarte sp. indet.	G
Rochefortia sp. indet.	G
Cardium californiense Deshayes	P G
Cardium ciliatum Fabricius	P G
Serripes grönlandicus Gmelin	G
Spisula alaskana Dall	G
Mya intermedia Dall	G
Saxicava pholadis Linné	G
Panomya ampla? Dall	G
Polyzoön	G
Turbellaria?	G
Balanus fragments	G

[a] G indicates St. George; P St. Paul.

specimens seven species appear to be new out of thirty-three which are specifically identifiable, or nearly 20 per cent.

The ensemble of the collection points to climatic conditions similar to those prevailing at present in the region, while the earliest Nome bed indicates decidedly warmer water. It is probable that this Pribilof fauna conformed to more rigorous conditions prior to the glacial epoch.

The St. George collection as a whole has only seven species identical with those found at Black Bluff, St. Paul Island, which latter fauna is doubtless Pleistocene. With the Pliocene second elevated beach fauna at Nome one-third of the St. George collection is identical, but in this third the characteristic warmer water species are not represented. So I conclude that the material obtained by Mr. Hanna represents a period later than the Nome second beach and earlier than that of the Black Bluff fauna. A list of the species is given in table 1. The type specimens are preserved in the U. S. National Museum.

BOTANY.—*The ancestry of maize.* J. H. KEMPTON, Bureau of Plant Industry. (Communicated by William R. Maxon.)

In a recent article entitled *The evolution of maize*, Weatherwax[1] raises again the issue of the origin of the genus Zea. He reviews the literature, summarizes the descriptions, and presents in a new light many of the morphological differences and similarities of *Zea mays* and the related plants, *Euchlaena luxurians* and *Tripsacum dactyloides*. Students of these genera will welcome the bringing together of these descriptions, accompanied as they are by excellent illustrations. Since the article aims at a comprehensive evaluation of the relationship of these genera, it is perhaps unfortunate that much of the "gross morphology" has been disregarded, with a consequent overemphasis of the organological features. There are, moreover, a few misstatements, and some of the views of previous workers seem to have been misinterpreted. It is hoped that a discussion of these points will contribute to a better understanding of the subject.

[1] WEATHERWAX, PAUL. *The evolution of maize.* Bull. Torrey Club 45: 309–342. 1918.

In the description of Zea, the statement appears that variation in this genus is mostly quantitative in nature, a conclusion hardly justified by the facts. The line of demarcation between quantitative and qualitative variation is, of course, more or less arbitrary, but there can be no question that Zea stands apart from related genera in the number of discontinuous variations. It is unfortunate that Weatherwax has not had the opportunity to become acquainted with the instructive variations isolated by experimental breeders.

Another statement that must be challenged is that branches of maize may arise "singly or two or more from one node" (p. 316). It is difficult to understand how this error survived a second reading. Reference is made, however, to a text figure for substantiation. This figure seems to have been drawn from a normal plant and furnishes no evidence of this most unusual type of branching.

Equally surprising, from a morphologist, is the confusing of husks or bracts with prophylla. On page 314 we learn, ". . . . and the shortness of its axis enables the leaf sheaths to cover the inflorescence and mature fruit. In some cases the laminae and ligules of these prophylla are present (Fig. 6) but often they are lacking (Fig. 7)." Again, in the legend under Fig. 7, page 315, "the prophylla have lost their laminae and ligules." That prophylla sometimes possess laminae and ligules would be an important observation, if true, but it seems clear that the author has failed to distinguish between these most interesting and highly specialized organs and the relatively unspecialized bracts, or husks. This confusion by a professed morphologist is the more astonishing in view of the unusual structure of prophylla and their consequent interest from a morphological standpoint.

In drawing attention to the unsatisfactory treatment accorded the female inflorescence of teosinte by previous investigators, Weatherwax has, inadvertently no doubt, misquoted Collins, and in justice a correction should be noted. We have, quoting from Weatherwax: "Collins' description[2] (p. 525) of the spike

[2] COLLINS, G. N. *The origin of maize.* Journ. Wash. Acad. Sci. 2: 520–530. 1912.

as 'one rowed' is equally misleading." In looking for this reference I have succeeded in finding only the following, which appears as a footnote on page 525 and not as a part of a description of this genus: "As might be expected theoretically the early generation of the hybrids between single-rowed teosinte and double-rowed maize occasionally result in an odd number of rows. Well formed ears with 3, 5, 7 and 9 rows have already been observed in such hybrids." Without the context the distinction between "single-rowed" and "one-rowed" may seem slight, but when contrasted with the double or paired rows of maize it is difficult to understand how the meaning could have been perverted.

The major part of the paper is devoted to a discussion of the relative merits of the several theories of the origin of maize, and the conclusion is reached that maize developed by simple evolution from a grass somewhat similar to the Andropogoneae. While this solution is not new, organological evidence is contributed which the author believes affords it additional support. In reaching his conclusions it would seem that Weatherwax has overlooked some important considerations and misinterpreted others, and it may be well, therefore, to examine his evidence somewhat in detail.

The author has found organological evidence of the perfect-flowered nature of all spikelets of the genera Zea, Euchlaena, and Tripsacum, a fact which satisfactorily accounts for the true-breeding perfect-flowered races of Zea but does not explain the infrequency with which such flowers are found in Tripsacum and Euchlaena. If well developed perfect flowers are ever found in the pistillate inflorescences of Euchlaena or Tripsacum, they occur very rarely and may not be compared with their relatively normal development in Zea. The importance of this disparity in the frequency of perfect-flowered variations should not be overlooked in determining whether Zea or Euchlaena is the more primitive type.

In indicating the evolution of these genera, the author has recorded the changes that have taken place and has constructed a seemingly plausible sequence of events which may prove mis-

leading. There is and can be no question that Zea, Euchlaena, and Tripsacum have a common ancestry, but whether the differences between Zea and the other genera can be more satisfactorily explained by ascribing the diversities to simple evolution from a single common ancestor than by assuming a hybrid origin is a question that to the writer's mind has not been fully appreciated by Weatherwax. To answer these questions, differences must be considered, as well as similarities.

One of the chief differences between Zea and the other genera lies in the form of the pistillate inflorescence, or ear, the origin of which has been the subject of much discussion. The theory receiving the greatest support is that of fasciation, proposed by Hackel[3] and accepted by Gernert,[4] Worsdell,[5] and others. This theory is open to the objection that it fails to account for the fact pointed out by Mrs. Kellerman[6] and Montgomery,[7] that the ear is the homologue of the central spike of the tassel. Collins[8] has called attention to the fact that the central spike is as much in need of explanation as the ear, and has suggested an alternative theory, which has been adopted by Weatherwax, that the central spike originated by the shortening of some of the branches of the panicle until they were reduced to paired spikelets. On this basis the ear is homologous with the central spike, the reduction of the branches having occurred before the male and female inflorescences were differentiated.

While the latter theory would seem to fulfill the conditions, the case for fasciation cannot be peremptorily dismissed without some explanation of the frequent occurrence of bifurcated ears which breed true. Further support of the fasciation theory is to be found also in a true-breeding race having fasciated and bifurcated central spikes, which we have succeeded in isolating. The full description of this mutation will be published shortly.

[3] Hackel, E. *Gramineae.* Engl. & Prantl, Nat. Pflanzenfam. 2: 1–97. 1889.

[4] Gernert, W. B. Analysis of characters in corn and their behavior in transmission. Champaign, Ill. 1912.

[5] Worsdell, W. C. The principles of plant teratology, Vol. 2. London. 1916.

[6] Kellerman, Mrs. W. A. *Primitive corn.* Meehan's Monthly 5: 44. 1895.

[7] Montgomery, E. G. *What is an ear of corn?* Pop. Sci. Mo. 68: 55–62, figs 1–14 1906.

[8] Op cit.

Contrary to Weatherwax's assertion, there is in reality no mathematical difficulty involved in developing ears with ten, fourteen, or eighteen rows by the fasciation of 4-rowed branches. Ears having rows in these numbers can be obtained by the abortion of a row of paired spikelets or the abortion of the pedicelled spikelets of one of the component branches, both of which phenomena are of rather frequent occurrence. Moreover, the writer is inclined to believe that a statistical investigation would probably show varieties with ten, fourteen, and eighteen rows to be less common than those having rows that are multiples of 4. The very large number of 8-rowed varieties and the complete absence of 6-rowed varieties have also to be considered.

In view of the fact that maize is intermediate in a great many respects between the specialized characteristics of teosinte and the more primitive characteristics found in pod corn, Collins conceived the idea that it probably originated as a hybrid between teosinte and a primitive grass having many of the characteristics of pod corn. Weatherwax's contention that pod corn can not be accepted as a "primitive type" seems beside the point, since no one but the very early writers has held such a view. The various types of pod corn do, however, afford a series of characters that may properly be called primitive, since they are shared by many species of Andropogoneae. The fact that these characters are not all combined in a single mutation, but have occurred independently in various combinations, would seem to strengthen rather than weaken this evidence that they are ancestral. And since there is no genetic obstacle to uniting the characters of the various types by properly selected matings, there can be no objection to their theoretical combination. Furthermore, since pod corn appears as mutations from highly specialized commercial varieties, there surely need be no surprise that the so-called earless plants have undeveloped ear buds in the axils of their leaves.

A confusion of terminology doubtless accounts for the disagreement between Collins and Weatherwax on the presence of staminate flowers in the branches of pod corn. There are, of

course, in pod corn as in the normal maize from which it mutated, two kinds of branches, those with shortened internodes borne on the upper part of the plant, known as ears, and the more or less elongated lower branches known as tillers or suckers. As is well known, the latter are frequently similar in all respects to the main stalk and may terminate in an entirely staminate panicle. In making the statement that staminate flowers had not been found on the branches of pod corn, Collins was referring to the upper branches, while Weatherwax in contradicting this observation is undoubtedly referring to the basal branches, or suckers. The imputation that suckers have been confused with independent plants would hardly occur to one familiar with genetical methods.

Another fundamental difference between pod corn and teosinte, which, through an apparent misunderstanding, Weatherwax has attempted to discredit, is the occurrence of branches in the axils of prophylla. Collins' statement that such branches were the rule in teosinte and had not been observed in pod corn meets with the disapproval of Weatherwax, who states that he has frequently observed such branches which can be induced by the destruction or injury of the terminal bud. As has been previously stated, Weatherwax fails to understand the fundamental distinction between prophylla and bracts, which may be due to the fact that the differences are of such a magnitude as to be easily detected with the naked eye and as such come under the heading of "gross morphology."

That all branches are *enclosed* in prophylla does not mean that they are borne in the axils of such prophylla, since these leaf-organs are borne on the short basal joints of the branches which they enclose! In Euchlaena and in some types of maize, branches are developed from buds in the axils of prophylla, as well as from buds in the axils of leaves and husks, but in pod corn we have never found such prophyllary branches. Secondary branches in the axils of husks are easily induced in almost any type of maize by preventing the development of the ear, but we have never succeeded in forcing the development of buds in the axils of prophylla. In view of the evident mis-

understanding it seems doubtful whether Weatherwax has found branches in the axils of the prophylla enclosing branches of pod corn. It has to be considered also that the significance of such a phenomenon depends in a large measure on the frequency of its occurrence. It may be expected that in course of time and by examining a sufficiently large number of plants an industrious morphologist would find an example of pod corn with branches in the axils of prophylla, though as yet none has been observed.

There is apparently also a similar misunderstanding with respect to the "mixed inflorescences" in teosinte. Collins states in effect that he has never observed pistillate flowers in the male panicle or staminate flowers in the female inflorescences of Euchlaena. It is not quite clear from Weatherwax's contradiction of this statement whether he refers to the panicle terminating the main culm or to the panicles terminating primary, secondary, tertiary, or branches of higher order. In examining several thousand plants of the commercial teosinte of Florida we have never found even an indication of pistillate flowers in the tassels of the main culms, and their occurrence in the tassels of basal primary branches is rare. Pistillate spikelets, however, are common in the terminal inflorescences of secondary branches and branches of a higher order. This point is important, since in both maize and teosinte the branches are less specialized than the main culms. Unless great care is exercised in growing plants, confusion is likely to arise between branches and main stalks. Unfavorable climatic conditions in the early stages of growth will often result in the abortion or only partial development of the main culm. This abortion of the main culm will not be detected at maturity unless the plants have been marked. While it may be that Weatherwax has actually found pistillate spikelets in the main panicle of the central culm, in view of the possibilities of error his statement should be accepted with reservation until more definitely substantiated.

With respect to the occurrence of flowers of both sexes in the female inflorescence, it is apparent that Weatherwax is again confusing two separate and distinct phenomena. Investigators

familiar with teosinte are well aware of the fact that the female spikes often terminate in staminate tips. These staminate tips correspond to the same phenomenon on the ears of maize, but the occurrence of entirely male spikelets definitely located at the less specialized tip should not be confused with perfect flowered spikelets located in the alveoli of the highly specialized rachis at the base of the spike. The occurrence of sharply differentiated staminate tips on the pistillate spikes of teosinte seems to emphasize, rather than minimize, the greatly specialized nature of the female inflorescences. The transition from single pistillate to paired staminate spikelets is abrupt and is accompanied by an equally abrupt change in the rachis and glumes.

It must be repeated that there is a complete absence of functioning stamens in the specialized pistillate portion of the spikes of teosinte, while in maize perfect-flowered spikelets not only have been *found* throughout the entire ear, but strains breeding true for this condition have been isolated. The fact that all species of the Maydeae are structurally bisexual should not be allowed to obscure the importance of this point.

A careful study of teosinte, not only in the large commercial plantings of Mr. Heinisch in Florida, but also in widely diverse environments and under carefully controlled breeding experiments, together with a study of hybrids between the Floridian and Mexican types, fails to show a variation at all comparable with that observed in even carefully bred varieties of maize. The chief support of a hybrid origin for maize lies not only in single character differences or similarities but also in the more general features which have been overlooked or lightly dismissed by Weatherwax. The greater frequency of variation in maize compared to almost any other species seems to the writer to offer a very reasonable ground for doubting its simple evolution from the same common ancestor with Euchlaena and Tripsacum.

Aside from the extreme variability, it is hard to understand, with Weatherwax's theory, how, sharing as they did the same habitat, Zea and Euchlaena ever became differentiated. They hybridize readily, the hybrids are perfectly fertile, and they become indistinguishable when grown together.

With respect to the many true-breeding abnormal forms, Weatherwax admits that a single ancestral type combining all of these cannot be visualized, but with this evidence he is still loath to accept an additional ancestor. The statement "that many of the tetratological conditions that do not fit into the foregoing theory (simple evolution) as reversions are not inherited" can hardly be passed unchallenged without an enumeration. Practically all maize breeders are familiar with many true-breeding tetratological forms which cannot be looked upon as reversions to a single ancestral line.

It is difficult to understand why the fundamental differences between Zea and other members of the Maydeae should be overlooked and a theory adopted whose chief support lies in the fact that teosinte and Tripsacum share with maize the rudiments of perfect flowers. It scarcely needs argument to prove that all are descended from perfect-flowered ancestors. The suppression of sex organs is a universal attribute of any unisexual organism and as a basis for proving relationship is equal in every respect to the observation of Weatherwax, "that common to all three genera (Zea, Euchlaena, and Tripsacum) is the jointed vegetative stem."

AGRICULTURE.—*The size of Maya farms.* O. F. COOK, Bureau of Plant Industry.

Among many parallel features of the ancient civilizations of Peru and Mexico were the methods of producing and distributing the supplies of food. Each householder had an assignment of land to produce food for the family. An area sufficient for a man and his wife was known in Peru as a *topo*, *tupu*, or *topu*. Another *topo* was granted for each boy and half a *topo* for each girl, perhaps because more feasts and ceremonies were required in raising boys. In addition to the fields assigned to families, the people of each community were charged with the cultivation of lands set aside for the support of the priests and for other public purposes. A national system of storehouses was maintained by the Inca government as a protection against distress from crop failures or other local disasters.

The system followed by the Mayas of Yucatan has been described by Brinton as follows:

Personal tenure of land did not exist. The town lands were divided out annually among the members of the community, as their wants required, the consumption of each adult being calculated at twenty loads (of a man) of maize each year, this being the staple food.

I mention this particularly in order to correct a grave error in Landa's *Relacion de las Cosas de Yucatan*, p. 130. He says, "Suelen de costumbre sembrar para cada casado con su muger medida de CCCC piés que llaman *hun-uinic*, medida con vara de XX pies, XX en ancho y XX en largo." The agrarian measure *uinic* or *hun uinic* (one man) contained 20 *kaan*, each 24 yards (varas) square. One *kaan* was estimated to yield two loads of corn, and hence the calculation was forty loads of the staff of life for each family. Landa's statement that a patch 20 feet square was assigned to a family is absurd on the face of it.[1]

Since Bishop Landa's *Relacion* is by far the largest body of direct knowledge of the Maya civilization, it is worth while to remove an unwarranted impeachment of the practical value of this important record. The passage quoted by Brinton may not be free from ambiguity of construction, but the charge of "grave error" is hardly to be justified. Neither the Spanish original nor the accompanying French translation of Brasseur de Bourbourg is "absurd" in the manner alleged. Instead of a patch 20 feet square, a square of 400 feet on each side is indicated by Landa; that is, 400 times as much land as Brinton supposed. Confusion doubtless arose from the use of the words *medida* and *vara* in senses that are somewhat unusual, though hardly to be misunderstood in relation to the context. Substitution of *que* for *lo qual* also makes Brinton's transcription of the passage appear more casual and ambiguous than the original. The sense may be stated as follows:

They follow the custom of sowing for each married man and his wife an area 400 feet square, which they call *hun uinic*, measured with a stick 20 feet long, 20 sticks in breadth and 20 in length.

Brinton does not state the source of the figures that he would substitute for Landa's, but since the two versions fall within the same order of magnitude they may be said to confirm rather than to contradict each other. The Bishop's "one man" area

[1] BRINTON, D. G. The Maya Chronicles, 27, 1882, the second paragraph as a footnote. See also, Essays of an Americanist, 438, 1890.

amounts to 160,000 square feet, the other to 103,680 square feet, in our system corresponding to 3.67 acres and 2.38 acres, respectively. It could not be expected that all of the lands would produce equally, and the report may relate to different districts where the sticks used in measuring the fields were not of the same length.

The word *kaan*, defined by Brinton as an area, seems to have been the name of the stick or cord used in measuring, but since each *kaan* of length would represent one-twentieth of the *hun uinic* unit, the *kaan* might serve also as a measure of area. Using a 20-foot stick, 20 *kaan* in length would amount to 400 feet, and the *kaan* area to 8000 square feet. Reducing the stick to 16 feet would restrict the *kaan* as an area to 5120 square feet, nearly equivalent to Brinton's *kaan* of 5184 square feet, or square of 24 yards. In eastern Guatemala *canquib* or *kankib* is the native name of small, slender palms of the genus Chamaedorea, with smooth, long-jointed trunks less than half an inch in diameter, ideally adapted for measuring-rods. The usual meaning of *can* is "yellow," while *quib* is a general name for small reed-like palms.

The harvest of forty-man-loads of maize from the Maya farms in Yucatan might be estimated roughly at about 80 bushels, not a large yield for two or three acres, but maize is seldom very productive in tropical countries of low elevation. At altitudes of 9,000 to 11,000 feet in the Cuzco district of Peru a topo of maize, equivalent to about seven-tenths of an acre, is expected to yield 8 to 10 fanegas of 260 pounds each, corresponding roughly to 42 and 52 bushels per topo, or from 60 to 75 bushels per acre. The topo is reckoned now at 4,000 square varas, equivalent to 30,820 square feet, but may have been larger in ancient times. That the family requirement of maize under the Inca system should have been smaller than among the Mayas could be explained by more extensive use of other foods, as potatoes, ocas, ullucus, and quinoa, in the Peruvian tablelands.

The ancient agricultural system of the Pima Indians of Arizona provided a farm unit of 100 steps "of the same foot," as stated by Russell, used in dividing the cultivated lands among those

who helped to build the irrigation ditches. Farms of 100 or 200 steps were assigned, "according to the size of the family." Since a "step of the same foot," at an ordinary walking gait, is a little more than four feet, the Pima unit may be estimated at about four acres, or slightly larger than the Maya "one man" area, 400 feet square. Allotments of 10 acres of irrigable land are now being made to each member of the Pima nation.

ORNITHOLOGY.—*Spizixidae, a new family of pycnonotine Passeriformes.* HARRY C. OBERHOLSER, Biological Survey.

Further researches in the family *Pycnonotidae* apparently make necessary the removal of still another group as the type of a separate family. The genus *Spizixos* is not at all closely allied to its present family associates, and the proper course seems, therefore, to be its segregation as a new family, which will bear the name

Spizixidae, fam. nov.

Diagnosis.—Similar to the *Pycnonotidae,* but bill shorter, stouter, and somewhat compressed, its height at base much more than half the length of the exposed culmen, and equal to the length of bill from nostril (instead of much less), its width at the anterior end of nostrils equalling or exceeding one-half the length of the exposed culmen (instead of much less); lateral outline of maxilla somewhat convex (instead of concave); mandible, basally broad, its width at the beginning of the interramal feathering (angle of gonys) equal to the length of gonys (instead of only one-half to two-thirds the length of same); interramal space anteriorly broadly rounded, almost U-shaped (instead of narrow, triangular, and rather pointed—nearly V-shaped), and rami posteriorly almost parallel, instead of being widely divergent; gonys much up-curved distally; culmen strongly decurved from exposed base; bristles of chin much developed, reaching beyond the middle of the bill; nostrils entirely and densely covered by antrorse bristly feathers.

Family characters.—Bill thick, short and pyrrhuline; culmen rounded, curving down from the frontal feathers; angle of gonys opposite the anterior end of nasal fossae; gonys sharply ascending distally, keeled distally, but rounded proximally; terminal portion of maxilla tomium strongly notched; lateral outline of maxilla convex; interramal space anteriorly broadly U-shaped, the rami posteriorly almost parallel; nostrils small and rounded, situated at the anterior edge of the nasal fossae and nearly on a level with the surrounding rostral surface; entire nasal fossae covered by stiffish antrorse feathers; head entirely feathered and with long nuchal hairs; tail of twelve feathers, slightly rounded,

and long, occupying more than one-half the total length of bird; wings moderately short and rounded, the first primary spurious, but more than half the length of the second, and the tertials short; feet of moderate size; tarsi short, and scutellate, but sometimes rather indistinctly so, claws of moderate size.

Type genus.—*Spizixos* Blyth.

Remarks.—This new family seems to be a considerably specialized offshoot of the Timaliine stem. In its nuchal hairs, feet, tarsi, and general characters, it is evidently related, at least in a general way, to the Pycnonotidae. So far as we can judge from its external structure it does not exhibit any distinctively corvine, parine, or fringilline characters. Of the genera composing the family *Pycnonotidae*, the *Spizixidae* seem most closely allied to *Criniger* Temminck. In the closely covered nostrils they resemble the Irenidae, but are, of course, otherwise different, and apparently lead from *Criniger* in the Pycnonotidae to the Irenidae

The two species and the two additional subspecies which make up this new family of birds, are all at present included in the genus *Spizixos* Blyth. A new genus is, however, needed for one of the species, and by the institution of this a new alignment of forms will necessarily follow.

Spizixos Blyth.

Spizixos Blyth, Journ. Asiat. Bengal 14: 571. August, 1845. (Type by monotypy, *Spizixos canifrons* Blyth).

Generic characters.—Conspicuously crested; wing longer than tail; bill relatively less elevated, its height at base less than the length of gonys; subterminal commissural tooth of maxilla strongly developed, its infero-posterior salient angle sharp, about equal to a right angle, its anterior upper edge slightly concave to tip of bill.

Type.—*Spizixos canifrons* Blyth.

Remarks.—The type is the sole species, though this genus also includes a recently described subspecies.[1] The forms of this group are, therefore, *Spizixos canifrons canifrons* Blyth, *Spizixos canifrons ingrami* Bangs & Phillips.

Cophixus,[2] gen. nov.

Generic characters.—Similar to *Spizixos* Blyth, but head not crested; wing shorter than tail; bill relatively more elevated, its height at base at least equal to the length of gonys, often more; subterminal commissural tooth of maxilla less strongly developed, its infero-posterior

[1] *Spizixus canifrons ingrami* Bangs & Phillips. Bull. Mus. Comp. Zool. 58: 285. April, 1914. (Mengtsze, Yunnan, China.)

[2] κωφὸσ obtusus; ixus = ἰξὸσ, viscum.

salient angle obtuse, much more than a right angle; its anterior upper edge strongly convex to tip of bill.

Type.—*Spizixos semitorques* Swinhoe.

Remarks.—This new genus contains two nominal species. *Spixizos semitorques* Swinhoe, from eastern China, and *Spizixos cinereicapillus* Swinhoe from Formosa. The latter is, however, although confined to the island of Formosa, clearly but a subspecies of the former, as its individual variation indicates. The forms of the present genus, therefore, stand as: *Cophixus semitorques semitorques* (Swinhoe), *Cophixus semitorques cinereicapillus* (Swinhoe).

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

PHYSICS.—*The specific heat of platinum at high temperatures.* WALTER P. WHITE. Phys. Rev. **12**: 436–441. December, 1918.

The specific heat of platinum has been redetermined from 100° to 1300° with a precision estimated to be better than 0.3 per mille and with very satisfactory agreement with the results of Gaede at 100° and with those of Plato, Corbino, Magnus, and Fabaro at higher temperatures. Most published results below 100° appear to be 1 per cent or more too high. The atomic heat of platinum at constant volume is, from 100° up, above the value 5.96, indicated by Dulong and Petit's law and by the accepted kinetic theories of the solid state, and also increases regularly to 1300° and probably beyond that.

W. P. W.

PHYSICS.—*Heat convection in air, and Newton's law of cooling.* WALTER P. WHITE. Phys. Rev. **10**: 743–755. December, 1917.

In very narrow layers of air between vertical surfaces at different temperatures the convection currents, in the main, flow up one side and down the other, with eddyless (stream-line) motion. It follows that these currents transport heat to or from the surfaces only when they turn and flow horizontally, from which fact it follows, in turn, that the convective heat transfer is independent of the height of the surface. It is, according to the laws of eddyless flow, proportional to the square of the temperature difference and to the cube of the distance between the surfaces. As the flow becomes more rapid (*e. g.*, for a 20° difference and a distance of 1.2 cm.), turbulence enters, and the above relations begin to change. The change is apparently gradual, and the present results, as well as some obtained by other experimenters, are rather negative as to the possibility of expressing the flow simply

for the corresponding range of conditions, which covers those most usual in calorimetry. The results, however, are sufficient to serve as a practical guide in calorimeter designing. For the dimensions tested, the transmission of heat by convection in horizontal layers was a little over twice that in vertical. W. P. W.

PHYSICS.—*The necessary physical assumptions underlying a proof of the Planck radiation law.* F. RUSSELL v. BICHOWSKY. Phys. Rev. 11: 58–65. January, 1918.

In order to prove Planck's radiation law by means of the quantum theory, only two physical assumptions need be made: first, that energy is absorbed or radiated by a radiating system in quanta of $h\nu$; second, that a radiating system has the statistical properties of a perfect gas, *i. e.*, that Maxwell's distribution law holds for the distribution of the local values of the energy among the coordinates defining the state of the radiating system. (The usual auxiliary assumptions, such as Planck's oscillators or Larmor's regions of equal probability, are not only unnecessary but misleading.)

Although these two assumptions are sufficient for deriving the Planck radiation law, both of them, and particularly the latter, are very dubious, it being almost unthinkable that a radiating system can have the statistical properties of a perfect gas and yet not have the equipartition law hold. For these and other reasons it seems necessary to give up at least the second of the quantum hypotheses and to assume that the distribution of energy in a radiating system does not obey Maxwell's law—that is, to assume that in a radiating system the distribution of the local values of the coördinates is a function not only of the energy of the system but also of some other variables. If we do this and assume, for definiteness, that the distribution of the local values of the generalized momenta is a function not only of the total energy E of the system but also of the Helmholtz free energy A, and further assume that the total energy of a radiating system cannot be less than a certain limiting value E_0 (E_0 turns out to equal $h\nu$), we can, following the methods of Gibbs and Ratnowsky, derive in a very simple manner the Planck radiation law, and moreover we can do this without assuming discreteness of radiant energy, without contradicting classical mechanics (equipartition does not hold for systems of this kind), without discarding infinitesimal analysis or without contradicting thermodynamics or the direct experimental evidence of the photoelectric effect that the $h\nu$ law holds only as a limiting case.

A translation of the mathematical part of "The entropy equation of solid bodies and gases, and the universal quantum of activity," by Simon Ratnowsky (Ber. Deutsch. Phys. Ges. **16:** 232. 1916) is appended.

F. R. B.

ORNITHOLOGY.—*A new bullfinch from China*. J. H. RILEY. Proc. Biol. Soc. Wash. **31:** 33–34. 1918.

A new form of *Pyrrhula erythaca* Blyth, particularly interesting by reason of its apparently widely isolated range in the mountains of Chili Province, China, was discovered by Geo. D. Wilder, of Peking, China. It differs from *Pyrrhula erythaca erythaca* in smaller size and several color characters. It is here named *Pyrrhula erythaca wilderi* in honor of its discoverer.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*A revision of the races of* Toxostoma redivivum *(Gambel)*. HARRY C. OBERHOLSER. The Auk **35:** 52–61. 1918.

Of the four described forms of *Toxostoma redivivum* only one has been generally considered valid. The study of a large amount of material now makes it possible to recognize three geographic races. These are, *Toxostoma redivivum redivivum* (Gambel) from southern California, with which *Toxostoma redivivum pasadenensis* (Grinnell) is identical; *Toxostoma redivivum sonomae* (Grinnell) from northern and central western California; and *Toxostoma redivivum helvum* (Thayer and Bangs) from northern Lower California.

H. C. O.

ORNITHOLOGY.—*Swan Lake, Nicollet County, Minnesota, as a breeding ground for waterfowl*. HARRY C. OBERHOLSER. Fins, Feathers and Fur **13:** 1–4. 1918.

A thorough biological survey of Swan Lake, Nicollet County, Minnesota, was made in 1917 to ascertain its value as a breeding ground for waterfowl. It appears to be one of the two or three best lakes in Minnesota for this purpose. It is not deep, and is filled with a large number of species of water plants, many of which furnish ideal food for various kinds of water birds. During the three days from July 25 to 27, 1917, twenty species of water birds were observed on the lake, and forty-three species of land birds in its immediate vicinity. The lake is valuable, especially to the state of Minnesota, as an aid in the conservation of the game supply, and it should have permanent protection.

H. C. O.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 808th meeting was held at the Assembly Hall of the Carnegie Institution, November 9, 1918, Vice-President HUMPHREYS in the chair; 65 persons present. The minutes of the 807th meeting were read in abstract and approved.

J. C. HAMMOND presented the first paper on *Observations of the solar eclipse of June 8, 1918, by the Naval Observatory Eclipse Expedition.* The paper was illustrated by lantern slides.

The party was located at Baker, Oregon. The program comprised (1) observing the times of the contacts, (2) photographing the corona, and (3) photographing the flash spectrum. The equipment consisted of a 5-inch equatorial, a 3-inch Fauth transit with a latitude level attached, three cameras of focal lengths 65 feet, 105 inches, and 33 inches, respectively, and three spectrographs, each employing a concave grating and used without slit.

A thin cloud or haze over the sun during totality affected the results. The times of the contacts were determined, good photographs of the inner corona and prominences were taken with the 65-foot photoheliograph, and some results of value will be obtained from a discussion of the spectrographs.

Discussion: This paper was discussed by Mr. C. G. ABBOT.

HERBERT H. KIMBALL and S. P. FERGUSON presented the second paper on *Meteorological phenomena of the solar eclipse of June 8, 1918.* This was illustrated by lantern slides.

The paper was a summary of meteorological observations obtained at about 55 Weather Bureau stations within the zone of 90 per cent obscuration of the sun, and of measurements of both incoming and outgoing radiation obtained at Goldendale, Washington, by means of a Smithsonian pyranometer and an Angstrom pyrgeometer.

At Goldendale the sky was partly overcast on the day of the eclipse, but clear about the sun during the totality. Between first contact and about 10 minutes after totality, approximately one-third the usual amount of radiation was received, and the temperature fell 3.6° C. During totality the outgoing radiation averaged about 0.162 calorie per min. per cm.^{2}, which is less than observations on clear nights would lead us to expect, probably because of radiation received from the cloud layer.

Preliminary analysis of the meteorological records indicates that, in general, the fall of temperature was comparatively small, the changes of pressure small and irregular, and the changes of direction of the wind apparently rather large, but irregular. The small change of temperature may be due, partly, to cloudy weather prevailing along the path of totality, and the irregular fluctuations of pressure and wind to conditions favoring the development of local storms.

Confirming results found in studies of other eclipses, the greatest changes of conditions, in most cases, occurred between five and twenty minutes after the passage of the shadow; also, there are evidences of inblowing and outblowing winds around the area of totality suggesting the circulation found during the eclipses of 1900, 1901, and 1905.

Discussion: This paper was discussed by Messrs. BAUER, ABBOT, and HUMPHREYS.

C. G. ABBOT presented the third paper on *Observations of the Smithsonian eclipse party, June 8, 1918*. This paper was illustrated by lantern slides.

Mr. L. B. ALDRICH assisted by A. KRAMER and by Rev. CLARENCE WOODMAN, a volunteer, observed the total solar eclipse near Lakin, Kansas, June 8, 1918. Besides noting general phenomena, Rev. Woodman observed times of contact as follows on Greenwich mean time:

Latitude 37° 53′ 04″ N.
Longitude 101° 17′ 51″ W.
1st Contact $10^h\ 19^m\ 48.5^s$
2d Contact $11^h\ 27^m\ 15.1^s$
3d Contact $11^h\ 28^m\ 37.3$
4th Contact $12^h\ 29^m\ 45.4^s$

He also exposed two 3-inch 11-foot focus cameras which had been set up and adjusted in the four days preceding the eclipse.

Messrs. Aldrich and Kramer observed with the pyranometer the radiation of the sun and sky separately and in combination from about 1 P.M. of June 8, through the eclipse until sunset and continued after sunset, observing the intensity of twilight on a horizontal surface. During totality and in the night they observed the nocturnal radiation.

The week of preparation was unfortunately so cloudy that no focus plates could be taken, and no rating of the camera driving clock on the sun could be made. Indeed as late as noon of June 8, it seemed that the sky would surely be overcast during the eclipse. However, the afternoon proved nearly cloudless apart from streaks of cirrus and occasional cumulous clouds.

The observers regarded the degree of darkness during totality as unexpectedly great, and the spectacle as unusually grand. Successful photographs of about 70 seconds' exposure were obtained, but they were somewhat marred by imperfect rating of the clock due to the bad weather.

Discussion: This paper was discussed by Mr. KIMBALL.

L. A. BAUER presented the fourth paper, by BAUER and FISK, on *Results of magnetic observations during the solar eclipse of June 8, 1918.* This paper was illustrated by lantern slides.

The solar eclipse of June 8, 1918, offered an exceptional opportunity for magnetic and allied observations, since somewhat over one-third of the belt of totality was situated in the United States. An interesting circumstance was also the fact that this eclipse was the repetition of the one of May 28, 1900, in connection with which systematic observations according to the first author's directions for the study of a possible magnetic effect during a total solar eclipse, were made. In response to the appeal sent out by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, magnetic data are available at present from seven stations within the belt of totality, sixteen stations outside of the belt but within the zone of visibility of the eclipse, and three stations outside of the zone; the stations covered the region of the earth from China, Australia, and the Philippines to Porto Rico. With a view to varying the conditions, the station selected by L. A BAUER for his work was at Corona, Colorado, the elevation of which is 11,500 feet; the changes in magnetic declination observed during the eclipse at this mountain station proved to be of special interest.

The various curves showing the results of the magnetic observations at the different stations, as projected on the screen, showed a number of extremely interesting features. It was pointed out that, in general, the most notable effects revealed by the magnetic curves did not occur according to absolute time nor according to local mean time, but followed closely the times at which the eclipse occurred at the different stations. The stations in the United States also revealed magnetic effects before the time of the local eclipse, resulting evidently from the easterly progression of the effects which had arisen in the portion of the earth over which the eclipse had already occurred. Not only were the conclusions reached with reference to the eclipse of May 28, 1900, and subsequent eclipses, verified by the effects observed during the eclipse of June 8, 1918, but a number of additional facts have been disclosed which will assist materially in the final analysis of this interesting phenomenon. It was again shown that the magnetic fluctuations observed during the eclipse are analogous in their nature to the solar diurnal variation, differing from it chiefly in degree.

Discussion. This paper was discussed by Mr. ABBOT.

HARVEY L. CURTIS, *Recording Secretary.*

THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

The 317th regular meeting of the Society was held in the hall of the Perpetual Building Association's Building, 1101 E St., N. W., December 4, 1918. Twenty members were present. President SASSCER presided.

J. R. HORTON, of the Bureau of Entomology, and CHARLES W. LENG, 33 Murray St., New York City, were elected to membership.

The president announced that he had appointed A. N. CAUDELL, L. O. HOWARD, and AUGUST BUSCK a committee to prepare for publication a biographical sketch and bibliography of Mr. Frederick Knab.

A vote of thanks was extended by the Society to the editor, Mr. BAKER, and the corresponding secretary, Mr. ROHWER, for their excellent work in successfully resuming publication of the Proceedings in spite of formidable difficulties.

The following were elected officers of the Society for the ensuing year: *President*, E. R. SASSCER; *1st Vice-President*, W. R. WALTON; *2nd Vice-President*, A. B. GAHAN; *Recording Secretary*, R. A. CUSHMAN; *Corresponding Secretary-Treasurer*, S. A. ROHWER; *editor of the Proceedings*, A. C. BAKER; *additional members of the Executive Committee*, A. N. CAUDELL, E. R. ELY, and A. L. QUAINTANCE; nominated to represent the Society as Vice-president of the Washington Academy of Sciences, S. A. ROHWER.

The regular program comprised the following:

SNODGRASS, R. E.: *Notes and exhibition of water-color drawings of fruit insects*. Mr. Snodgrass, who is engaged in illustrating in water-color for the Bureau of Entomology the life histories and character of injury of the principal insect pests of deciduous fruits, exhibited a collection of remarkably fine illustrations, the results of his work to date. In connection with the exhibition of drawings Mr. Snodgrass pointed out some of the interesting points in the life histories of his subjects. The drawings and accompanying remarks proved exceedingly interesting and the artist was highly complimented upon his excellent work by Messrs. CUSHMAN, ROHWER, GAHAN, and SNYDER.

A. B. GAHAN, *Recording Secretary*.

SCIENTIFIC NOTES AND NEWS

A *Guide to United States Government Publications* has been compiled by W. I. Swanton and has just been issued as Bulletin No. 2, 1918, of the Bureau of Education.[1] The bulletin gives not only information concerning the mailing lists, methods of distribution, lists of publications, and classes of publications issued by every office of the executive departments, but also a concise outline of the organization and functions of every office. The bulletin should prove useful to all who have occasion to use the publications of the Federal bureaus.

Dr. Charles Greeley Abbot, Director of the Astrophysical Observatory, has been appointed Assistant Secretary of the Smithsonian Institution.

Mr. J. C. Hostetter, of the Geophysical Laboratory, Carnegie Institution, has returned to Washington after a year's absence in charge of optical glass manufacture at the Charleroi plant of the Pittsburgh Plate Glass Company.

Mr. Logan Waller Page, director of the Bureau of Public Roads of the U. S. Department of Agriculture, died in Chicago on December 9, 1918, in his forty-ninth year. Mr. Page was born at Richmond, Virginia, January 10, 1870. He was geologist to the Massachusetts State Highway Commission and director of the testing laboratory of the Lawrence Scientific School of Harvard University from 1893 to 1900, when he entered the government service. He became director of the Office of Public Roads (later the Office of Public Roads and Rural Engineering) in 1905. Practically all of his work was devoted to the building and maintenance of public roads. He was a member of the Washington Society of Engineers, president of the American Highway Association, and actively connected with a number of other engineering societies.

Dr. J. N. Rose, of the National Museum, and his son, George Rose, who have been conducting botanical explorations in Ecuador during the past summer, returned to Washington early in December. Collections of nearly two thousand numbers were obtained.

Dr. A. Hoyt Taylor, professor of physics at the University of North Dakota, now lieutenant commander in the Navy, has resigned after a year's leave of absence, and will continue his work at the Bureau of Standards on naval radio communication.

[1] Obtainable from the Superintendent of Documents, price 20 cents.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 9 JANUARY 19, 1919 No. 2

MATHEMATICS.—*Note on rotations in hyperspace.* EDWIN BIDWELL WILSON, Massachusetts Institute of Technology.

In a recent paper C. L. E. Moore[1] has discussed rotations in hyperspace, by treating first the resolution of a complex 2-vector M into mutually completely perpendicular simple 2-vectors or planes. The problem is of sufficient interest, perhaps, to justify my sketching very briefly the method by which I attacked the problem of discussing rotations in hyperspace in a paper read before the American Mathematical Society[2] over ten years ago, but never published. My method was founded on the general reduction of the homogeneous strain to canonical form, and in particular on the work subsequently printed in this JOURNAL.[3] It is there shown that a real strain about a fixed point has four types of transformation as possibilities.

1. The tonic. That is a stretching along a fixed direction. This corresponds to a real root of the characteristic equation, and to each real root there is at least one such direction in space.[4]

2. The shear. This arises only when two or more real roots of the characteristic equation are equal, and consists in the

[1] MOORE, C. L. E. *Rotations in hyperspace.* Proc. Amer. Acad. 53: 651–694. 1918.

[2] See, Bull. Amer. Math. Soc. 13: 265. 1907.

[3] WILSON, EDWIN B. *Note on multiple algebra; the reduction of real dyadics and the classification of real homogeneous strains.* Journ. Wash. Acad. Sci. 7: 173–177. 1917.

[4] The multiplier may be negative, *i. e.*, the stretching may be accompanied by a reversal of direction; nevertheless for analytical reasons, we may speak of a fixed "direction."

simplest case of the superposition upon the stretching of a sliding parallel to the fixed direction, and proportional to the distance from the fixed direction, as is necessary if lines originally passing through the origin are to remain lines passing through the origin. The shear may be of various degrees of complexity; for example, if there are three equal real roots there is a plane through the fixed direction which is fixed, and in it the shear is simple; whereas the displacement of points not in this fixed plane is partly in the fixed direction and partly in another direction parallel to the fixed plane. (It is not necessary that there be shearing when there are multiple roots. It is clear that two different directions in space may be fixed with the equal ratios of stretching for those directions, and with the same ratio for all directions in their plane.)

3. Cyclotonic. This is a combination of stretching with elliptic rotation in a plane. It arises when there is a pair of conjugate imaginary roots in the characteristic equation. All lines are stretched in a definite ratio, and are turned through a definite "angle," provided angle be measured by the sectorial area in an ellipse concentric with the fixed point instead of by the sectorial area in a circle.

4. The cyclotonic-shear. In the simplest case, where the characteristic equation has a pair of conjugate imaginary roots, each occurring twice, the transformation consists in a cyclotonic change in each of two nonintersecting planes through the origin combined with a displacement parallel to one of the pairs. For conjugate imaginary roots of greater multiplicity various complexities of cyclotonic-shear are possible (It is not necessary, however, that shear accompany multiple roots in this case any more than in case the roots are real.)

A rotation is a transformation in which length and an angle remain unchanged. As length remains unchanged it follows that all the real roots of the characteristic equation must be either $+1$ or -1; for otherwise there would be at least one direction in which stretching took place. Moreover, the magnitudes of the imaginary roots must also be equal to $+1$, *i. e.*, the roots must be complex quantities or there would be at least one plane

in which stretching took place. Next, if a real root is double, there can be no shear corresponding to that double root, because in the shear all lines through the origin in a fixed plane through the fixed direction must change their direction, with the sole exception of the fixed direction itself, and an angle cannot remain always unchanged in the case of a shear. In like manner, it may be seen that when an imaginary root is multiple, the shearing terms must be absent if the strain reduces to a rotation.

If there are a certain number of real roots equal to $+1$, a space of the same number of dimensions is left absolutely unchanged. If there are a certain number of roots -1, these may be paired to represent a rotation of $180°$ in a certain number of planes, which will take care of all if the number of roots -1 is even. If the number is odd, there will be one direction left over, along which directions are reversed. This case corresponds not to a rotation, but to a reflection, and, consequently, the number of roots -1 must be even. The transformation of rotation, therefore, reduces to the identical transformation in a space of a certain number of dimensions, and to rotations through angles of $180°$ or otherwise in a number of independent planes sufficient to make up the total multiplicity of the hyperspace.

The fact that there are no shearing terms in the dyadic or in the matrix, Φ, means algebraically that the equation of lowest degree satisfied by the dyadic has only as many factors as there are different roots in the characteristic equation, each factor raised to the first power, namely:

$$(\Phi - \mathrm{I})(\Phi + \mathrm{I})(\Phi - e^{i\theta}\mathrm{I})(\Phi - e^{-i\theta}\mathrm{I}) \ldots\ldots = 0$$

or

$$(\Phi^2 - \mathrm{I})(\Phi^2 - 2\cos\theta\Phi + \mathrm{I}) \ldots\ldots = 0$$

It is necessary to point out that the different independent spaces which correspond to the different roots of the equation are perpendicular. Consider, for instance, any direction in a space corresponding to $+1$, and any direction in that corresponding to -1. The transformation leaves the first direction unchanged, and reverses the second, so that each angle is changed into its supplement; and if angles are to remain unchanged, the directions must be perpendicular. In like manner, there may

be considered a direction in the space corresponding to $+1$, and a direction in one of the planes in which rotation occurs. If the plane is not perpendicular to the direction, there is one line in the plane which is, and only one. The rotation will turn this line into another direction in that plane, and, consequently, will change a right angle into some other angle; hence, the plane must be perpendicular to the direction.

In a similar way, consider two planes in which there is rotation. Unless the planes are perpendicular, there is just one line in one of the planes which is perpendicular to the other plane. The operation of the rotation in the two planes will throw this line into some other, and again angles will be changed, which is impossible in a rotation; and the planes must, therefore, be perpendicular It therefore follows that the fixed space and space in which directions are reversed and the various planes in which there are rotations are all mutually perpendicular in the sense of complete perpendicularity.[5]

This brings the discussion to an end by the determination of the fundamental existence-theorem for rotations in generalized space. It is the theorem which Moore establishes prior to subsequent work. The method of treating rotations in ordinary space which was given by Gibbs in his lectures, and may be found in the *Vector Analysis*,[6] is dependent upon the knowledge that in three dimensions a rotation has a fixed axis. Much of the subsequent work, however, could, I believe, be carried over to higher dimensions in much the same way as the simpler case was treated by Gibbs.

CHEMISTRY.—*Note on the Bucher cyanide process for the fixation of nitrogen.* EUGEN POSNJAK and H. E. MERWIN, Geophysical Laboratory, Carnegie Institution of Washington.

In the course of an investigation of the Bucher cyanide process[1] undertaken by this Laboratory at the request of the

[5] The treatment may, of course, be carried through analytically by taking a general vector ρ and its transform $\phi\rho$ calculated from the canonical form, and by expressing the conditions on the coefficients of δ which require constancy of length and invariance of angle.

[6] WILSON, EDWIN B. Vector Analysis (Gibbs). New York, Charles Scribner's Sons, 1901 See pp. 334–347.

[1] Journ. Ind Eng Chem. 9: 233 1917.

Nitrate Division of the Ordnance Department of the Army, it was found by means of microscopical examinations that the nitrogen-bearing constituent of some of the crude technical products manufactured by this process consisted principally of some other substance than ordinary sodium cyanide.

Ordinary sodium cyanide was found to be an essentially isotropic substance, crystallizing in cubes, and having a refractive index of 1.452 ± 0.003. After this cyanide had been fused, slight double refraction amounting to about 0.005 was observed.

The material found in the technical products above mentioned appeared in weakly doubly refracting colorless grains about 0.03 mm. in diameter. The refractive indices are $\alpha = 1.527$, $\beta = 1.532$, $\gamma = 1.537$. The optic axial angle observed was so near 90° that the optical character could not be determined.

Evidently only chemical tests were made by Bucher. It was therefore necessary to repeat his experiments to establish whether sodium cyanide or this other substance was formed by his reaction. The Bucher process, as known, consists in heating a mixture of sodium carbonate, charcoal, and iron powder (catalyst) in a stream of nitrogen at a temperature above 900°. The reaction is written as follows:

$$Na_2CO_3 + 4C + N_2 \rightleftharpoons 2NaCN + 3CO$$

In our experiments, mixtures containing varying amounts of sodium carbonate, carbon, and iron were prepared. Each was placed in an iron boat within an electric furnace which contained a reaction chamber consisting of a copper tube closely fitting within one of silica glass. A stream of nitrogen was passed through the tube while a certain temperature between 900° and 1000° was maintained for several hours. The reaction product was rapidly cooled by lifting the tube out of the furnace without interrupting the flow of nitrogen and was then examined microscopically. In all experiments sodium cyanide, together with some of the ingredients of the original mixture, proved to be present, which confirms the reaction given by Bucher.

As it did not seem feasible to investigate the conditions of formation of the substance in question at the factory, attempts

were made to recover it in sufficient purity from the crude product with the view of preparing a sample for analysis.

Recovery by distillation was first tried in the following way: The crude product was put in a copper tube which was closed at one end and which fitted inside a similar tube of silica glass. These tubes were placed in an electric furnace and heated about three hours at 800° while the other end of the tube was connected with a vacuum pump and cooled. When taken apart no change could be observed.

The same experiment was repeated at approximately 975°. It was now necessary to run the pump constantly as an evolution of gas was taking place. On taking the apparatus apart metallic sodium was found in the cold portion of the tube. Inasmuch as the crude product usually contains sodium carbonate, the following reaction probably took place:

$$Na_2CO_3 + 2C = 2Na + 3CO$$

Microscopical examination of the crude product in the tube showed that the substance in question still remained. Thus distillation appears not to be a suitable method for its separation.

According to Bucher,[2] sodium cyanide can be easily distilled out of his briquets at a temperature even below 800°. These experiments therefore substantiate the microscopical evidence that the samples of the crude product examined do not contain any appreciable amount of sodium cyanide.

The investigation of the chemical nature of the substance in question is being continued.

PHYSICAL CHEMISTRY.—*Some physical constants of mustard "gas."*
LEASON H. ADAMS and ERSKINE D. WILLIAMSON, Geophysical Laboratory, Carnegie Institution of Washington.

Some time ago it was desired, for military purposes, to know the compressibility of so-called mustard gas. Accordingly, the necessary measurements were carried out at this laboratory,

[2] Loc. cit., p. 246.

and at the same time certain other properties of this substance were determined from its behavior under hydrostatic pressure.

The compound 2,2-dichloroethylsulfide[1]—$(C_2H_4Cl)_2S$—is known as mustard gas or mustard oil, and is, when pure, a colorless, oily liquid which boils about 217°. The compressibility was measured by the same method and using the same apparatus as that already described.[2] The procedure, in brief, is as follows: The material to be compressed is surrounded by kerosene in the interior of a thick-walled steel cylinder, one end of which is closed while the other end is fitted with a piston and leak-proof packing. By means of a hydraulic press the piston is forced into the cylinder, thus subjecting the kerosene and the given material to hydrostatic pressure and thereby decreasing the volume of each. The decrease in volume of the substance for each increment of pressure is determined from a pair of readings of pressure and corresponding piston displacement. Pressures were measured by an electrical method, the precision being such that one scale division was equal to about one megabar;[3] the displacement of the piston was read on a dial micrometer which was graduated to 0.01 mm. Temperature regulation was obtained by an electric heating coil of asbestos-covered "nichrome" wire wrapped around the heavy steel cylinder and covered with an insulating layer of felt. About 10 g. of the material was contained in a steel capsule closed at the top and terminating below in a capillary which dipped into a cup containing mercury. Pressure could thus be transmitted through the mercury seal to the interior of the capsule.

Table 1 shows the results for the decrease in volume (at 31.5°) of the liquid under pressure. The second and third columns of the table give for two separate runs the values of $-\Delta v/v_0$ where Δv is reckoned from the initial pressure, $P_0 = 392$ megabars, and v_0 is the volume[4] of the liquid at 31.5° and atmos-

[1] Also called thiodiglycolchloride. Conf. BEILSTEIN, Vol. I, p. 358. Ber. Deutsch. Chem. Ges. 19: 3260. 1886.

[2] Journ. Amer. Chem. Soc. 41: January, 1919.

[3] 1 megabar = 10^6 dynes/cm². = 1.020 kg./cm². = 0.987 atm.

[4] This was calculated from the known density which at 20°, 25°, 30°, and 35°, respectively, is 1.274, 1.269, 1.264, and 1.258.

pheric pressure. The values of Δv as a function of P may be represented by a power series yielding the equation

$$\Delta v/v_o = 4\ 24 \times 10^{-5} (P - P_o) - 6\ 3 \times 10^{-5} (P - P_o)^2$$

however, the results are expressed equally well by the exponential equation

$$-\Delta v/v_o = 0\ 118[1 - e^{-0\ 364 \cdot 10^{-3} (P - P_o)}] \qquad (1)$$

which gives a more reasonable course to the compressibility curve and hence is to be preferred for extrapolating to zero pressure In the third column of table 1 are shown the values of $-\Delta v/v_o$ calculated from equation (1)

By differentiation this equation becomes

$$-dv/dP = 49\ 5\ e^{-0.364 \cdot 10^{-3} P} \qquad (2)$$

from which we find the compressibility ($-dv/dP$) at $P = 0$ to be $49\ 5 \times 10^{-6}$ per megabar, while at 1000 and 2000 megabars, respectively, the compressibility is $34\ 4 \times 10^{-6}$ and $23\ 9 \times 10^{-6}$

TABLE 1

DECREASE IN VOLUME OF MUSTARD "GAS" UNDER PRESSURE

PRESSURE MEGABARS	$-\Delta v/v_o$ (OBS)		$-\Delta v/v_o$ (CALC)
	(1)	(2)	
392	0 0000	0 0000	0 0000
840	0 0175	0 0179	0 0177
1280	0 0327	0 0331	0 0326
1713	0 0447	0 0450	0 0450

After the conclusion of the measurements of compressibility the freezing pressure and resultant change of volume at a few temperatures were determined. This could be done without removing the material from the apparatus. By referring to figure 1 it may be seen how the desired quantities may be obtained from a series of readings, at constant temperature, of pressure P, and piston-displacement R. When freezing or melting of the substance in the capsule takes place, P remains constant while R increases or decreases and the resulting discontinuity at once locates the freezing pressure for the given temperature.[5] Moreover, the change in volume on melting may be

[5] Conf. BRIDGMAN, Proc Amer. Acad 47: 415. 1911.

obtained by multiplying the cross-section of the piston by the quantity $R_2 - R_1$ which is obtained graphically (see Fig. 1).

The necessary readings must be taken with decreasing pressure since, on account of the propensity of liquids for under-cooling to a temperature several degrees below their melting point, they will generally support a pressure far beyond the true freezing pressure before solidification takes place.[6] Dichloroethylsulfide requires at ordinary temperatures about 1000 megabars super-pressure to start it freezing. This corresponds to an under-cooling of 14°.

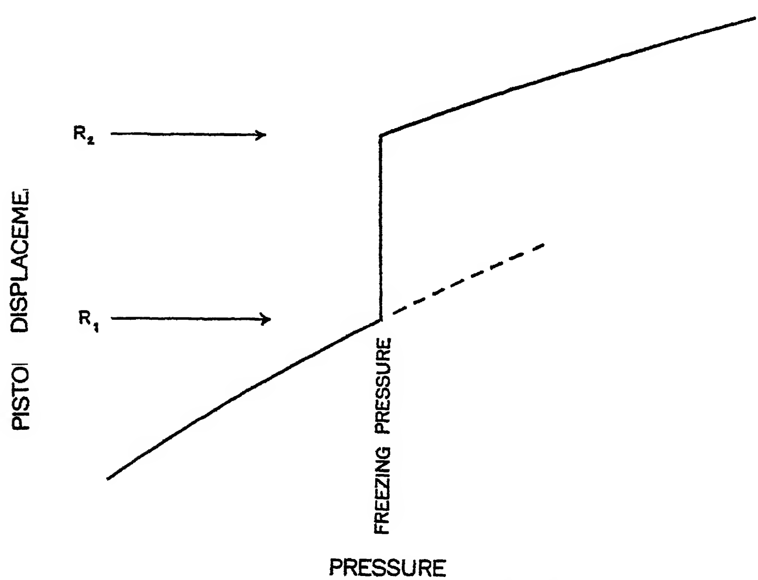

Fig. 1. Diagram to illustrate how the freezing pressure and consequent change of volume may be obtained by plotting pressure against piston-displacement. When the pressure on the liquid is raised, freezing does not take place promptly and the liquid thus passes into the undercooled or metastable region, as shown by the dotted line.

The results for the freezing-points at several pressures are shown in figure 2 and in table 2, which also gives the change of volume $V - V^s$ in cm³. per gram. From these results it may

[6] A corresponding superheating of the solid has been observed only in rare instances.

be seen that the compressibility measurements of table 1 were extended by about 500 megabars into the region of undercooled liquid. At ordinary pressures the melting point of the sample used is 13 9°, but although it was a carefully purified and colorless preparation, a slight variation in pressure during melting was observed. This indicates a small amount of impurity remaining in the material and doubtless the melting point of pure dichloroethylsulfide at $P = 1$ is a few tenths of a degree higher than the figure here given.

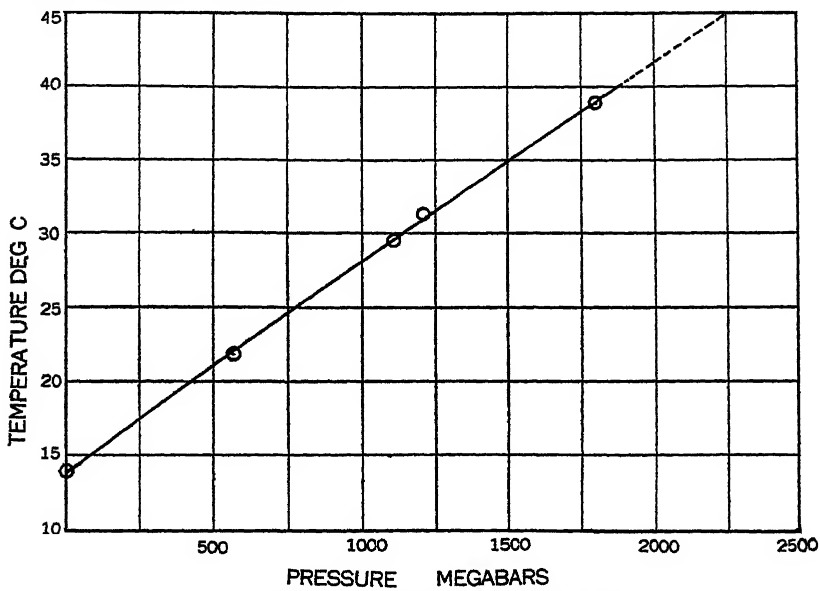

Fig. 2. The small circles in this figure represent the freezing points at various pressures. The smooth curve drawn through the circles is slightly concave toward the pressure axis.

In order to test for the possible existence of other solid modifications of this substance, the pressure on it was increased to 12,000 megabars at 38°; but no new forms were discovered.

From the data contained in table 2 we may calculate by the Clausius-Clapeyron equation the latent heat of melting. Thus

$$\Delta H = 0.02391 T(V_l - V_s) dP/dT,$$

where ΔH is the latent heat in calories per gram, T is the absolute temperature, $V_l - V_s$ is the change of volume on melting in

cm³./g., and dP/dT is the slope of the $P-T$ curve expressed in megabars per degree; practically it is the pressure in megabars required to raise the melting point one degree. Over the range of temperature covered by our measurements we find

$$\Delta H = 25 \text{ cal. per gram.}$$

This is a value which is higher than the latent heat of melting

TABLE 2

RESULTS FOR FREEZING PRESSURES, AND CHANGE OF VOLUME OF FREEZING

TEMP. °C.	FREEZING PRESSURE MEGABARS	$V_l - V_s$ CM³./G.	dP/dT MEGABARS/DEG.	ΔH CALC.
13.9	1	(0.054)[a]	68	—
21.9	570	0.050	71	25
29.6	1110	...	—	—
31.4	1210	0.047	74	25
38.9	1800	0.042	77	25

[a] By extrapolation.

of most substances. On the other hand the compressibility and change of volume upon freezing do not differ markedly from the average for organic liquids.

BOTANY.—*A peculiar species of Lasiacis.* A. S. HITCHCOCK, Bureau of Plant Industry.

In 1759 Linnaeus described *Panicum divaricatum*[1] from Jamaica, distinguishing the species as divaricately much-branched. This is the first species to be described of a group having perennial branched, woody clambering or trailing stems, broad, flat blades, and panicles of smooth, roundish spikelets, set obliquely on the pedicels, the indurate fruit with a woolly tip. The aspect of the plants is that of a shrubby climbing bamboo. Several allied species have been described and referred to the genus Panicum. In 1864 Grisebach[2] recognized the group as a

[1] Syst. Nat. ed. 10. 2: 871. 1759.

[2] Fl. Brit. W. Ind. 551. 1864.

section of Panicum and gave to it the name Lasiacis, meaning woolly tip. The aspect of the species is so distinct and the technical spikelet characters so pronounced that the present writer elevated this section to the rank of a genus in 1910.[3] Lasiacis includes 13 species ranging from Mexico and the West Indies to Paraguay, one species entering the United States in semitropical Florida.

Lasiacis ruscifolia (H. B. K.) Hitchc. & Chase (*Panicum compactum* Swartz), is more variable and has a wider range than the other species. In an account of the genus as represented in the West Indies[4] occurs the following note:

"In all the Trinidad specimens the spikelets contain a second sterile lemma, a character not found in any other species known to us. This second sterile lemma equals the first, contains a hyaline palea, and infolds the fruit rather more closely than the sterile lemma commonly does in other species. The fruit borne one joint higher on the rachilla consequently faces in the direction opposite to the one in Paniceae, that is, the palea side of the fruit faces the second instead of the first glume."

A reconsideration of the group leads me to the conclusion that we have here a distinct species, for not only is there this unusual character of a second sterile lemma but also a distinct geographical range. Of the group to which it had been referred, all the specimens from Trinidad, the lower Orinoco, and eastern Brazil have a second sterile lemma, while outside of this range, that is, north and west, there is but one sterile lemma in all the specimens examined. In other respects, such as shape of blades and panicle, pubescence, shape and size of spikelets, the new species does not differ from *L. ruscifolia* from which it has been separated. The specimens of the new species, *Lasiacis anomala*, agree closely among themselves in all these characters, but also agree with many specimens referred to the more variable species *L. ruscifolia*.

The peculiarity of the case under consideration consists in the nature of the single diagnostic technical character, the second

[3] Contr. U. S. Nat. Herb. 15: 16. 1910.

[4] HITCHCOCK AND CHASE. *Grasses of the West Indies.* Contr. U. S. Nat. Herb. 18: 339. 1917.

sterile lemma. To those unfamiliar with the morphology of the grass spikelet it may be explained that the spikelets of the tribe Paniceae are characterized by two membranaceous bracts (glumes) at the base or outside, a third bract (sterile lemma) like the glumes in texture, and often enclosing a staminate flower but producing no seed, and finally a fertile lemma, which is indurate or at least thicker than the glumes, and which incloses a seed. The presence of a second sterile lemma is contrary to our concept of the whole tribe and if found here and there among our specimens would be looked upon as a teratological development. *A priori* one would be inclined to assign generic rank to a species or group of species possessing this character. In the case before us, however, the specimens possessing this character are indistinguishable in other respects from *L. ruscifolia*. Even specific rank is granted only because of the distinct range and the uniformity of the specimens. A technical diagnosis follows:

Lasiacis anomala Hitchc. n. sp.

Stems woody, branching, clambering over bushes, glabrous, the main culm as much as 5.5 mm. thick, and 5 meters long; sheaths glabrous or more or less pilose, striate, ciliate on the margin, densely villous on the collar; ligule a short ciliate membrane; blades ovate-lanceolate or elliptic lanceolate, as much as 10 cm. long and 3 cm. wide on the main flowering culms, usually 4–6 cm. long and 1–2 cm. wide on the lateral flowering branches, rather thin, narrowed and usually asymmetric at base, sometimes a little cordate-clasping, puberulent, or sometimes glabrate on the upper surface; panicles oblong-ovoid, 7–10 cm. long, 3–5 cm. wide, those on the lateral branches smaller, the lower branches somewhat distant, spreading or somewhat reflexed, all rather compactly flowered, puberulent, the pedicels angled, rather stout, 1–2 mm. long; spikelets ovoid, becoming nearly globose at maturity, 3–4 mm. long; first glume about one-third, second glume about two-thirds, as long as the spikelet; first and second sterile lemma about equal and about as long as the fertile lemma, the glumes and lemmas slightly woolly at the tip, the second sterile lemma infolding the fruit more closely than usual for the first lemma in other species; fruit ovoid-globose, obtuse, because of the presence of a second sterile lemma the palea side facing the second glume.

Type in the U. S. National Herbarium, no. 865557, collected along the edge of jungle, Fort George Road, Port of Spain, Trinidad, November 27, 1912, by A. S. Hitchcock (Amer. Gr. Nat. Herb. no. 595).

DISTRIBUTION: Trinidad to eastern Brazil.

SPECIMENS EXAMINED.

TRINIDAD: *Broadway* 2504, 2564, 2627; *Bot. Gard. Herb.* 2303; *Hitchcock* 10001, 10063, 10117, 10136.

VENEZUELA: Santa Catalina, *Rusby & Squires* 358; Island of Margarita, *Miller & Johnston* 184.

BRAZIL: Rio Branco, *Kuhlmann* 3358; Ceara, *Gardner*, 1889, 1894.

TECHNOLOGY.—*The determinateness of the hysteresis of indicating instruments.* F. J. SCHLINK, Bureau of Standards.

STATEMENT OF THE PROBLEM

The purpose of the present paper is to set down briefly the results of one of several concordant preliminary experiments carried out to determine to what extent hysteresis or variance determinations with respect to nonintegrating mechanical measuring instruments are themselves sufficiently definite and reproducible to warrant wide application in instrument testing, calibration, and utilization. The conclusion is reached that no extraordinary experimental care is required to arrive at hysteresis determinations of very definite utility, and that, under stated conditions, such determinations are of a highly reproducible character. These results are forecast in a paper just completed by the author, to which the reader may refer for a general discussion of hysteretic cycles in the operation of measuring instruments and of the fundamental relation which such cycles bear to testing and calibration.[1]

APPARATUS AND METHOD

In order to minimize the experimental difficulties and to permit of useful generalization of the results of the investigation, the instrument chosen as the basis for this work was a spring-controlled self-indicating weighing scale of the stabilized-platform pointer-and-dial type, a sort commonly used for the weighing of postal and express parcels, and to a very limited extent of vegetables and other low-priced commodities of trade. The choice of this particular type of instrument, shown dia-

[1] *The concept of resilience with respect to indicating instruments.* To be published in the Journ. Franklin Inst., February, 1919.

grammatically in figure 1, was influenced by the following major considerations:

1. It comprises many elements typical of measuring instruments generally, including: (*a*) a helical force-resisting spring; (*b*) a link work of several jointed bars; (*c*) a rack and pinion for magnifying the motion of the parts and transmitting it to a pointer rotating over a full circle of graduations; (*d*) a large

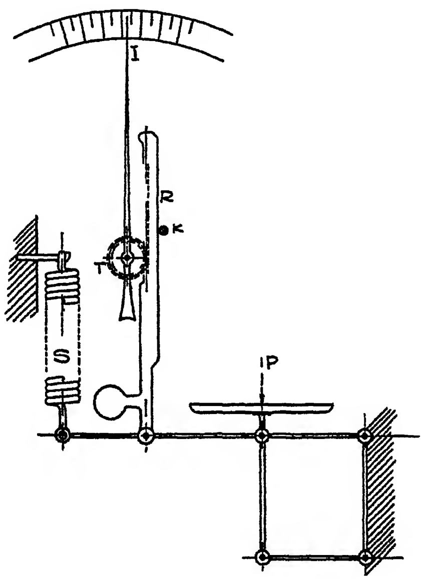

Fig. 1. Schematic illustration of mechanism of stabilized-platform pointer-and-dial type of spring scale. It will be noted that an eccentric disposition of the load on the platform is associated with a horizontal reaction in the check-rod (the lowermost link shown). The friction of the terminal journal bearings of this rod is proportional to this reaction, and hence to the product of the load itself and the displacement of its center of gravity from the center of the platform.

mechanical backlash (0.20 to 0.28 radian—11° to 16°—at the pointer) which is only partially compensated by gravitational force-closure.

2. The independent variable, *viz*, the load weighed, is essentially nonhysteretic and, therefore, admittedly reproducible with very high precision.

3. The aggregate fractional resistances of the apparatus are inherently large and moreover subject to ready control

within a wide range by simply varying the point of application of the load upon the platform in a direction parallel to the plan of the platform-supporting linkwork.[2]

4. As a consequence of the large frictional resistances, the variance of the indications of such a scale is so great as to be very easily observed and has, in common with that of many other crude and ill-constructed instruments, hitherto been deemed quite incapable of systematization or regularization. (Such scales are in fact so "unreliable" in their indications when read in the ordinary way, that their general use in trade is commonly prohibited by regulation.)

In order to afford accurate control over the position of application of the load, which, as has been stated, is a factor largely determining the aggregate amount of hysteresis of scales of this type, the standard weights used were suspended from below by cords secured at opposite ends of a light horizontal bar superimposed on the platform. Projecting downward from the center of this bar was secured a rubber stud or tip serving to localize the load within a small and determinate area on the platform while holding the bar itself above the platform and free from contact with it.

Since such scales are not artificially damped, gradual movement of the platform and pointer to their positions of rest at the several loads was provided for in the one direction by gentle and careful application of the weights manually, and in the other by the use of the relatively slow motion of the rack-and-pinion gear of a microscope stand by which a vertical rod was gradually withdrawn from contact with the upper surface of the platform after the removal of a given weight increment. By these means it was possible to assure aperiodic, reasonably steady, and shockless motion of the pointer, without overshooting of the rest point. The reasons and basis for this method are discussed in detail in the first reference cited. Regularization of operation of the scale, or the setting up of the cyclic state, treated in the same reference, was carried out before beginning the experiment by simply operating the scale a number of times

[2] See Bureau of Standards Technologic Paper No. 106.

over the actual maximum range of movement involved in the weighing of the capacity load.[3] Limitations of space prohibit

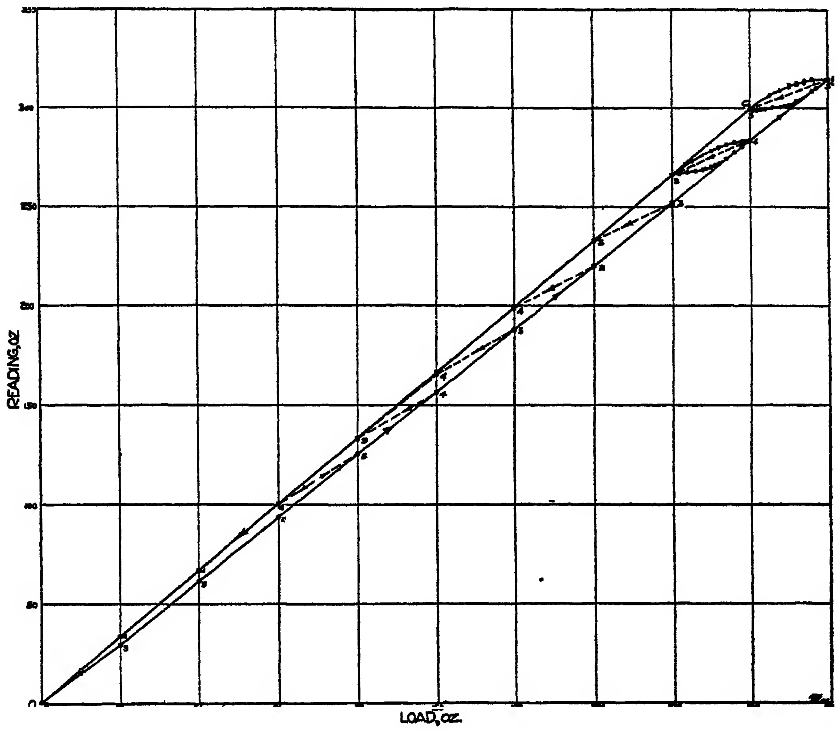

Fig. 2. Results of cyclic calibrations of stabilized-platform pointer-and-dial type of spring scale. Dotted lines connect points in a series of observations in which the detail path of the function was not then determined. The numbers to the right of the determinations indicate the number of the check observations taken, which gave substantially (see text) the same value as the observation recorded.

detailed consideration of these prerequisites in the present necessarily brief discussion.

[3] It was important to determine whether cyclic states set up on different occasions were actually identical, and to this end, the scale was strongly jarred and disturbed between successive runs, so as to insure definite dislocation of the acquired relations of journals and bearings, gearing, etc., within the limits, of course, of the clearances obtaining. Renewed cyclic operation of the scale brought about a regularization as perfect as could be desired, a result hardly less than astonishing, when the essential crudity of the instrument is considered. The finish and fit of the moving parts of this type of scale are of a sort that would be considered intolerable in any ordinary engineering instrument, *e. g.*, a Bourdon gage or a pocket voltmeter.

THE PARTICULAR RESULTS OBTAINED

Figure 2 presents the results of the cyclic calibration of a scale of the type described having the following general constants:

Range of graduation: 0 to 20 pounds, corresponding to rotation of the pointer through 2 revolutions = 4π.

Number of joints having relative motion, 7 (including duplicates as below; actual number of single journals and bearings 10). Turning pairs: duplicated, 5; not duplicated, 1. Higher pairs toothed gearing, 1.

Displacement, for the purpose of the experiment, of the point of application of the load from the line of centers of the link or stem supporting the platform, 7.0 cm.

Interval of graduation: 1/2 ounce = 1/32 pound = 1/640 or 0.0016 (approx.) of the nominal capacity.

Interval of estimation of pointer position for the purposes of the experiment: 0.1 ounce = 1/3200 or 0.0003 (approx.) of the nominal capacity.

After taking the readings reproduced in the figure, the drift of indication at full load was examined and found to amount to but 0.5 ounce in nine and one-half hours. On removing the load the zero reading exhibited a drift of 1.2 ounce to practically its initial value in 1 hour. The amount of the drift occurring during the course of the series of hysteresis observations recorded was probably negligible, and certainly at no time greater than 0.1 to 0.2 ounce. The existence of drift in directly measurable amount in this scale is believed to be the result of an easily remediable structural defect, *viz*, weakness of a certain portion of the inelastic sheet metal framework supporting the mechanism.

The following are the particular results, many of which appear directly in the graph:

1. The hysteresis loop,[4] or any portion of it, except at such a critical region as that designated *BC* in the figure, determined under the condition of slow aperiodic change of reading, was practically reproducible within a maximum deviation of one- to two-tenths of a graduation or at the largest separation of the loop where the relative precision is high, within a precision of about one or two parts in one hundred. It is to be noted that this small amount of dispersion of readings corresponds to a mutual displacement of repeated readings of but one-half the

[4] It is to be noted that the hysteresis obtained is for the major part the result of frictional resistances and, concomitantly, of bearing clearances. (See Bureau of Standards Scientific Paper No. 328.) It is known that only a relatively very small portion of the hysteresis observed can be the result of elastic hysteresis of the resisting spring of the scale.

width of the lines of the diagram. It is believed that a reproduction of the cycles even more precise would have resulted, had more delicate means of releasing the load upon the pan, and more rigid supports for the apparatus, been at hand.

During the experiment, the zero point remained surprisingly constant except that at the completion of the second run, it dropped sharply by three-tenths of a graduation, after which being readjusted to its initial value it remained stable except for the drift before mentioned, throughout a great number of subsequent observations. This displacement of the zero was undoubtedly due to an accidental irreversible slip of some loosely secured part of the exterior frame of the scale, which was notably deficient in rigidity, or of the dial.

2. At the critical region *BC* and other regions of beginning backward movement of the mechanism, the existence of a marked passivity due to imperfectly compensated backlash, increased the dispersion of successive observations considerably

3. The curves corresponding to reversal of the change of load before the extreme range of indication under investigation has been reached, are rapidly asymptotic severally to the upper and lower branches of the major loop, respectively.

4. The major loop tends to a decidedly skew lenticular form, roughly triangular, a result which is the direct consequence of the force system obtaining in this type of instrument, in that the frictional resistances tend to increase proportionally to the load, when the reactions in the stabilizing check are large. Other indicating instruments are more likely to give a loop of nearly symmetrically lenticular form.

GENERAL CONCLUSIONS

The general conclusions educible in the main from the present data, though fully supported collaterally by a considerable mass of experimental data necessarily omitted here, and by analogy, are the following:

1. The hysteresis loops obtained in the specified cyclic calibration of a (nonintegrating) mechanical measuring instrument nearly free from transient after-effects at rates of operation ob-

taining in the experiment, are highly reproducible and invariant in themselves, *even in the presence of very considerable instrumental friction* and the resulting so-called unreliability of indication.

2. If the instrument is used therefore under the conditions hereinbefore specified as defining the manner of its calibration, the positiveness and certitude of its indications over a very large portion of its range of indication are enormously increased, as compared with the results of operation in the ordinary and unregularized manner.

3. The middle portion of the calibration loop while in general exhibiting the largest absolute range of variability or variance of indication, in the ordinary manner of operation of the instrument, is the region most useful for obtaining results of the highest relative precision in the cyclic manner of operation above outlined.

4. Knowing the operational history of the instrument subsequent to regularization,[5] accurate reduction of a given indication can be carried out by this method with complete elimination of first-order variance.

5. The limiting values of the variant (casual or nonrepetitive) errors of such an instrument can be accurately set down upon the performance of a calibration of the type referred to, for any given range of operation in question, since the major loop corresponding to that range circumscribes and completely encloses

[5] In this connection it is clear that one of the factors tending to make the history of the instrument movement uncertain can be eliminated by application of critical or over-critical damping, since the effect of this expedient is to obviate the more or less irregular and indeterminate oscillations of the indicator about its rest point, which would normally depend upon the rate and manner of change of the independent variable during its application. The utility of such damping is especially marked, for instance, in the case of the controlled use in the laboratory, of automatic weighing scales which commonly revert to zero between weighings, since in such cases, the damping assures approach to the rest point over an accurately determinate functional path. In this connection it should be mentioned that critical or over-critical damping will be definitely disadvantageous if regular reversion of the instrument to its zero cannot be depended upon. Moreover, if the scale in question is to be used without correction of its readings, its adjustment to critical or over-critical damping implies that the calibration of the dial shall have been performed with respect to the curve of increasing readings, while the application of simple additive corrections, if they are to be used, is to be carried out with reference to the same branch of the hysteresis loop.

all minor or secondary loops observed over ranges of indication between its own terminal limits.

6. When the result of (4) is impracticable or inconvenient on account of the uncontrolled nature of the service to which the instrument is subjected, the best average result in the use of an instrument will in general be obtained when its scale values are adjusted to the mean[6] of the upper and lower limits of the maximum hysteresis loop rather than to the lower branch thereof, since when the cyclic history is unknown or indeterminate, indications within the loop are indefinitely more probable of occurrence than indications on its periphery.

[6] The mean is a first approximation to the position of the "normal" calibration line, in the absence of specific information regarding the skewness of the chance distribution of indications *across* the loop.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

PHYSICS.—*The general character of specific heats at high temperatures.* Walter P. White. Proc. Nat. Acad. Sci. **4**: 343–346. November, 1918.

The specific heats of three forms of silica and two silicates (alkali feldspars), determined for temperatures up to 1300°, indicate that the atomic heats at constant volume for the substances increase above the theoretical value 5.96, as the heats of metals have been known to do, and hence that such increase is a very general phenomenon, as has been suspected. W. P. W.

PHYSICS.—*Calorimetric lag.* Walter P. White. Journ. Amer. Chem. Soc. **40**: 1858–1872. December, 1918.

The lag effects of bodies external to calorimeters, although more complicated in expression, are found to follow the same general laws as the simpler lag effects already described. More carefully stated than previously, these effects prove to be three: (1) equivalent to the heat capacity of the calorimeter; this can be eliminated if a calorimeter is directly calibrated; (2) much smaller, depending on the amount of thermal leakage; this can be avoided, if necessary, by using the adiabatic method; (3) dependent on the jacket temperature, which disappears for constant jacket temperature; this one causes the calorimeter to have a different effective heat capacity when used adiabatically.
W. P. W.

INORGANIC CHEMISTRY.—*The ternary system MgO–Al_2O_3–SiO_2.* G. A. Rankin and H. E. Merwin. Amer. Journ. Sci. **45**: 301–325. April, 1918.

The temperature-concentration relations of the various crystalline phases in equilibrium with liquid in the ternary system MgO–Al_2O_3–SiO_2 have been investigated, and are represented by diagrams and a model. A ternary compound, $2MgO.2Al_2O_3.5SiO_2$, unstable at its

melting point and considerably affected by solid solution has been observed in two forms. The μ-form (unstable) crystallizes from glass at temperatures below about 950°, and transforms at somewhat higher temperatures into the α-form (stable). The properties of both forms, but especially the α-forms, are close to those of the mineral cordierite. The effects of solid solution in flattening two of the boundary curves of the field of this compound are discussed. The preparation and properties of crystalline aggregates of substances which dissociate when melting are considered. Crystals of natural cordierite dissociate when melting. Brief consideration is given to the effects of FeO in magnesian rocks and minerals H. E. M.

INORGANIC CHEMISTRY.—*Solubility and fusion relations at high temperatures and pressures.* GEORGE W. MOREY. Journ Engin. Club Phila. 35: 509–519. November, 1918.

An address, giving a popular discussion of the principles underlying the solubility relations of binary systems composed of both volatile and nonvolatile components. In addition, some new compounds of the alkalies with Al_2O_3 and Fe_2O_3 are described, as well as a new method for determining solubilities under difficult experimental conditions. G. W. M.

PHYSICAL CHEMISTRY.—*The laws of chemical equilibrium.* ERSKINE D. WILLIAMSON and GEORGE W. MOREY. Journ Amer. Chem. Soc. 40: 49–59. January, 1918.

In examining the complicated chemical systems which present themselves in the study of geophysical problems it is found that the approximate formulas used for dilute solutions break down and prove worse than useless even for qualitative application. The monumental work which the genius of Willard Gibbs evolved in 1876 remains the safest guide and that to which reference must necessarily be made. The extreme mathematical setting with which he surrounds his arguments has militated against the general use of his results by chemists, and a consequence of this is that much ink has been spilled in proving by roundabout and far from rigid methods, theorems which are either explicitly stated by Gibbs or are so readily deducible from his equations as to be implicit in his work. This paper has therefore been written as an attempt to popularize, in so far as such a term can be used in this connection, the derivation of the fundamental equations and to deduce from them such additional formulas as are found neces-

sary for the derivation of the theorems bearing on the chemical side of equilibrium. The applications of these theorems to actual cases will be discussed in later papers. R. B. S.

PHYSICAL CHEMISTRY.—*Pressure-temperature curves in monovariant systems.* GEORGE W. MOREY and ERSKINE D. WILLIAMSON. Journ. Amer. Chem. Soc. 40: 59–84. January, 1918.

Willard Gibbs, in his paper "On the equilibrium of heterogeneous substances," derives expression giving the relation between the variations in pressure and temperature in monovariant systems. The authors derive from this equation two fundamental theorems concerning the relations of the $P-T$ curves in such a system, for the case where a linear relation exists between the compositions of r or fewer phases in a system of r components. These considerations make possible (with no other knowledge than the composition of the phases at an invariant point) the fixing of the order of succession of the $(n + 2)$ $P-T$ curves which proceed from an invariant point in a system of n components and (when the state of aggregation of the phases is known in addition) the fixing of their actual position within fairly narrow limits. This is illustrated by considering the $P-T$ curves which proceed from the five quintuple points in the ternary system H_2O–K_2SiO_3–SiO_2. Gibbs' general equation is not in a form which is convenient to apply. A general method is given for casting it into a convenient form for practical use and a concrete interpretation of the coefficients involved is given. The application of this equation to the actual slope of the $P-T$ curves, and especially to the change in slope with change in composition of phases of variable composition, is discussed in detail, taking as examples typical $P-T$ curves from the ternary system H_2O–K_2SiO_3–SiO_2. R. B. SOSMAN.

GEOLOGY.—*Some manganese deposits in Madison County, Montana.* J. T. PARDEE. U. S. Geol. Survey Bull. 690–F. Pp. 131–143. 1918.

The deposits are along the west side of Madison Valley near Cherry and Wigwam creeks and in the foothills east of Jefferson Valley, near Renova, localities that are, respectively, 70 and 30 miles southeast of Butte, Mont. Though the deposits are small, they yield ore that is almost free of silica and is therefore very desirable for making ferro-alloys. They are also of interest because the manganese in them is

primarily of sedimentary origin, and accordingly they differ from most of the other manganese deposits known in this general region, which are related to metalliferous quartz veins.

On Wigwam and Cherry creeks irregular lenslike bodies of manganese oxides, chiefly psilomelane and subordinately manganite and wad, are found in an ancient marbleized limestone that underlies the Cambrian Flathead quartzite. The general features of these deposits clearly show that the ores were deposited in solution cavities and have also made room for themselves by replacing the limestone. Their composition and structure suggest that they were deposited by surface waters circulating through joints or other openings in the limestone, probably during the Tertiary period. Under these conditions the only apparent source of the manganese is the limestone itself, which contains small proportions of manganese and iron oxides.

Iron ore and manganiferous iron ore are exposed about 3 miles southwest of Renova. The localization of the deposits at the top of shales overlying the Flathead quartzite and their close association with an old surface of erosion suggest that they are portions of an iron-bearing stratum enriched by weathering when the land was being worn down to the level of the old surface and therefore are to be regarded as primarily of sedimentary origin. If this is the true explanation, similar ore bodies are to be expected at the same geologic horizons in the neighboring districts. R. W. STONE.

GEOLOGY.—*The structure and stratigraphy of Gravina and Revillagigedo islands, Alaska.* THEODORE CHAPIN. U. S. Geol. Survey Prof. Paper 120-D. Pp. 83–100. 1918.

The discovery of fossils of Jurassic or Cretaceous age has made possible some changes in the geologic mapping of Gravina Island. This paper is a supplemental report on the region and discusses the distribution, character, structure, stratigraphic relations, age, and correlation of rocks ranging from Devonian to Quaternary. R. W. STONE.

GEOLOGY.—*The Nesson anticline, Williams County, North Dakota.* A. J. COLLIER. U. S. Geol. Survey Bull. 691-G. Pp. 211–221, with map and section. 1918.

The Nesson anticline, discovered by a U. S. Geological Survey party in 1917, is a fairly well marked arch or dome about 30 miles east of

Williston. It is of interest because the rocks of North Dakota in general lie nearly flat, and because an artesian well drilled a few miles west of the crest of the anticline yields a small flow of gas. The stratigraphy and structure are described, and it is suggested that wells be drilled nearer the crest of the anticline in search of a larger flow of gas.

R. W. STONE.

GEOLOGY.—*Geology and oil and gas prospects of the Lake Basin field, Montana.* E. T. HANCOCK. U. S. Geol. Survey Bull. 691–D. Pp. 101–147, with maps, sections, and illustrations. 1918.

Describes the Cretaceous and Tertiary stratigraphy of an area northwest of Billings, discusses the structural folds and numerous faults in detail, and recommends that drilling be done in the Big Coulee-Hailstone dome in a search for oil and gas. If that dome proves barren, the possibility that oil and gas occur in commercial quantities in the Lake Basin is believed to be very slight. R. W. STONE.

MAMMALOGY.—*East African mammals in the United States National Museum. Part. I. Insectivora, Chiroptera, and Carnivora.* N. HOLLISTER. Bulletin 99, United States National Museum. Pages 1–194; 3 text figures; plates 1–55. August 16, 1918.

This first volume of a bulletin dealing with the extensive collection of East African mammals preserved in the National Museum, to be completed in three parts, consists of a general introduction, brief historical account of the collection, a map with a dictionary of localities and annotated lists of specimens of the insectivores, bats, and carnivores. The collections made by the Smithsonian African expedition under the direction of Col. Theodore Roosevelt, 1909–10, and by the Paul J. Rainey expedition, 1911–12, form the basis of the work, but all specimens from Sudan, Eritrea, Abyssinia, Somaliland, Lado Enclave, Uganda, British East Africa, German East Africa, and Zanzibar, received by the Museum from any source, are listed. These collections contain 1,833 specimens of mammals of the three orders, representing 155 species. There are 64 types. Generic and specific synonymies; type localities and location of type specimens; lists of specimens with critical notes; tables of external, cranial, and dental measurements; and field notes recorded by the collectors are given. The plates illustrate the skulls of all type specimens. N. H.

ORNITHOLOGY.—*Food habits of the swallows, a family of valuable native birds.* F. E. L. BEAL. U. S. Dept. Agr. Bull. **619**: 1–28; pls. 1–2. 1918.

So far as agriculture is concerned, there is no more useful family of birds than the swallows. Of the thirteen species of this group occurring in the United States, seven are so widely distributed that their food habits are of much economic importance. These are *Progne subis*, *Petrochelidon lunifrons*, *Hirundo rustica erythrogastris*, *Iridoprocne bicolor*, *Tachycineta thalsassina*, *Riparia riparia*. and *Stelgidopteryx serripennis*. The study of the food of these species shows that they are, like the rest of the swallows, practically not at all harmful to man, since they injure neither wild nor cultivated fruit or seeds, nor molest other birds. With the exception of one species, *Iridoprocne bicolor*, all the United States swallows are almost exclusively insectivorous, yet they do not disturb domestic bees or silkworms or devour unusual numbers of other beneficial insects. On the other hand, they feed on some of agriculture's worst insect pests, among them the cotton-boll weevil, clover weevil, alfalfa weevil, and chinch bug.

Since swallows feed almost entirely while on the wing, it follows that most of the insects they catch are flying species. Hymenoptera, Diptera, Hemiptera, and Coleoptera, form about eighty-five per cent of the food of the swallows in the United States. Orthoptera, a favorite item of food with many birds, and Lepidoptera are not eaten to any considerable extent. Among the food elements of each of the United States species examined there were found a great number of different species of insects, and lists of such discovered during the course of stomach examinations are given; that under *Petrochelidon lunifrons* amounts to 149. The only North American swallow that subsists to any extent on vegetable matter is *Iridoprocne bicolor*; in the case of this species to the extent of twenty per cent. Most of the vegetable fruit of this bird is made up of the berries of the bayberry; the rest of such wild berries as those of the red cedar and Viriginia creeper.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Notes on North American birds. V.* HARRY C. OBERHOLSER. The Auk **35**: 185–187. 1918.

The North American goshawk, *Accipiter atricapillus* Wilson, appears to be a subspecies of the European goshawk, and its two present subspecies should, therefore, stand as *Astur gentilis atricapillus* (Wilson); and *Astur gentilis striatulus* Ridgway. The American golden-crowned kinglets are evidently subspecies of the European bird, and their names

should thus become *Regulus regulus satrapa* Lichtenstein, and *Regulus regulus olivaceus* Baird. The form of fox sparrow called by Riley *passerella iliaca altivagans* has been discredited by most recent authors, but is shown by further study to be a recognizable race. The same is true of *Melospiza melodia inexspectata* Riley from Moose Lake, British Columbia. H. C. O.

ORNITHOLOGY.—*The crow and its relation to man.* E. R. KALMBACH. U. S. Dept. Agr. Bull. 621, 1–92; pls. 1–2; figs. 1–3. 1918.

This bulletin concerns only the races of the common crow, *Corvus brachyrhynchos*, with its various subspecies. These together inhabit practically all the United States and Canada. In the eastern United States the species is common and ranges over all kinds of country. It is one of the species that gather into roosts, particularly during the winter season, and at such times as many as nearly 300,000 birds sometimes assemble. Its close association with man makes its economic relations of much importance, and owing to its practically omnivorous habits the study of its habits presents more complicated problems than that of almost any other North American bird. In fact, not less than 656 specifically different items have been identified in stomach examinations. The present investigation is based on 2118 stomachs and some 3000 circulars of inquiry. The results show that the chief food of the crow consists of corn and insects; the latter chiefly Coleoptera, Orthoptera, Lepidoptera (larvae), and Hemiptera. Some spiders and crustaceans are also taken, as well as reptiles and amphibians, together with small mammals, principally rodents. One of the crow's most injurious habits is the destruction of wild birds and their eggs, and young poultry; but the latter can be partly if not wholly prevented by proper care. In some places, particularly in the southern United States, the crow often resorts to carrion for food, and under similar circumstances molests livestock.

The conclusion regarding the economic status of *Corvus brachyrhynchos* reached through the present investigation is that when feeding on injurious insects, crustaceans, rodents, and carrion it is beneficial; but when destroying small reptiles, amphibians, wild birds. poultry, corn and other crops, and disturbing livestock, it is injurious. Any necessary means should be employed to prevent its depredations, but the species is at times too beneficial to be entirely exterminated. It has practically no natural enemies, and a reasonable reduction of numbers by man in areas where there are too many crows is desirable.

HARRY C. OBERHOLSER.

VITAL STATISTICS.—*The relation between birth rate and death rate in a normal population and the rational basis of an empirical formula for the mean length of life given by William Farr.* ALFRED J. LOTKA. Quart. Publ. Amer. Statist. Assoc. 16: 121. 1918.

In a previous publication it was shown by the author that under constant conditions the relation between birth rate per head b and death rate per head d in an isolated population approaches the form

$$1/b = \int_0^\infty \epsilon^{-(b-d)\,a}\, p(a)\, da \qquad (1)$$

where $p(a)$ is the probability, at birth, that a random individual will reach age a.

When the relation (1) is plotted in rectangular coordinates it bears an outward resemblance to a hyperbola.

We may write (1) in the parametric form:

$$b = 1/L + mr + nr^2 + \ldots \qquad (2)$$

$$d = 1/L + (1 - m)r + nr^2 + \ldots \qquad (3)$$

where r is the natural rate of increase of the population and L is the mean length of life (expectation of life at birth).

Neglecting the second and higher powers of r it is easily shown that (2) and (3) are equivalent to the relation (4) between b and d,

$$\left(b - \frac{1-m}{L}\right)\left(d - \frac{m}{L}\right) = \frac{m(1-m)}{L^2} \qquad (4)$$

which, it will be seen, is indeed hyperbolic in form.

On the other hand, Equation 4, when expressed as a relation between $^1/_b$ and $^1/_d$ assumes the simple linear form

$$\frac{1-m}{b} + \frac{m}{d} = L \qquad (5)$$

a relation which is identical in form with Farr's empirical formula for the mean length of life

$$\frac{1}{3} \cdot \frac{1}{b} \times \frac{2}{3} \cdot \frac{1}{d} = L \qquad (6)$$

The empirical cofficients $^1/_3$ and $^2/_3$ which occur in Farr's formula thus receive a rational interpretation.

Numerical illustrations taken from British Statistics are given in the original. A. J. L.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The Board of Managers met on November 25, 1918. Progress was reported on arrangements for a meeting place for the affiliated societies and the problem offered by the rapidly increasing cost of publication of the JOURNAL was considered.

The Board of Managers met on December 13, 1918. The Editors were authorized to transfer the contract for printing the JOURNAL for 1919 from the Williams & Wilkins Company, of Baltimore, to the Eschenbach Printing Company, of Easton, Pennsylvania.

The following persons have become members of the ACADEMY since the last issue of the JOURNAL: Rear Admiral GEORGE WASHINGTON BAIRD, U. S. N., Retired, 1505 Rhode Island Avenue, Washington, D. C.; Dr. ATHERTON SEIDELL, Hygienic Laboratory, Public Health Service, Washington, D. C.

ROBERT B. SOSMAN, *Corresponding Secretary.*

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 587th regular meeting of the Society was held in the Assembly Hall of the Carnegie Institution, Saturday, November 30, 1918; called to order at 8.10 p.m. by Vice President HOPKINS; 35 persons present.

Deaths of the following members were noted: DOUGLAS C. MABBOTT, killed in France; D. E. LANTZ, former Recording Secretary of the Society, victim of the recent epidemic of influenza; and FREDERICK KNAB.

Informal communications were presented as follows:

Dr. L. O. HOWARD called attention to a communication and specimens he had received from Charles Russell Orcutt, of California. The specimens had been identified by Dr. Paul Bartsch as a noxious European snail and had been discovered by Mr. Orcutt in a restricted area in California. Dr. Howard told of the steps that were being taken by the state to exterminate this newly imported species. This communication was commented upon by Dr. Bartsch, who mentioned other introduced species of snails which had become pests.

Dr. T. S. PALMER brought to the attention of the Society that the year 1918 had been a very prosperous one for the A. O. U. in spite of wartime conditions. There are 950 members of the A. O. U., of whom 75 are in France. Of the latter, DOUGLAS C. MABBOTT, also a member

of the Biological Society, had been killed. Doctor Palmer called attention to the several species of birds of paradise now on exhibit by the New York Zoological Society. He also referred to the increased cost of food seeds for caged birds incident to the war. The question of food seed shortage and substitute was discussed by Mr. W. L. McAtee

Major R. W. Shufeldt spoke of various preserving fluids for anatomical, pathological, and zoological specimens. He exhibited several specimens preserved by them, and called attention to some of their advantages.

The regular program was as follows:

A. S. Hitchcock: *Some notes on the botany of Long's Peak, Colorado.* It was illustrated by numerous lantern slides.

M. W. Lyon, Jr.: *Influenza.* A brief account of the symptomatology and etiology of the recent epidemic of influenza.

The paper was discussed by Dr. H. S. Bennett, L. O. Howard, R. W. Shufeldt, W. P Taylor, and others.

The 588th regular and 39th annual meeting of the Society was held in the Assembly Hall of the Carnegie Institution Saturday, December 14, 1918; called to order at 8.00 p.m. by President Rose; 18 members present.

On recommendation of the Council the following named persons were elected to membership: Maunsell S. Crosby, W. Lee Chambers. Charles B. Cory, Charles C. Deam, George L. Fordyce, C. I, Clay, Albert O. Garrett, Morton J. Elrod, Henry W. Fowler, H. M. Denslow, H. Gifford, John Dryden Kuser, V. A. Huard, Arthur H. Helme, Philip Dowell, Edward A. McIlhenny, W. E. Saunders, Frank Smith, Aretas A. Saunders, W. B. Mershon, E. Lawrence Palmer, Lynds Jones, Althea R. Sherman, Robert Thomas Moore, Frank L. Burns, Harry B. Weiss, Frederic C. Kennard, Charles Theodore Ramsden, Carl Otto Rosendahl, Samuel F. Rathbun, Reginald Charles Treherne, Alexander Howard MacKay, Raymond J. Pool, P. A. Taverner, C. B. Williamson, Joseph Mailliard, Joseph Francis Charles Rock, J. Chester Bradley, James Alexander Munro, Charles W. Howard, Frank S. Daggett, Frank T. McFarland, Charles A. Shull.

Reports of Officers and committees for the year 1918 were received.

Election of officers for the year 1919 resulted as follows:

President, H. M. Smith; *Vice Presidents,* A. D. Hopkins, Vernon Bailey, N. Hollister, A. S. Hitchcock; *Recording Secretary,* M. W. Lyon, Jr.; *Corresponding Secretary,* W. L. McAtee; *Treasurer,* N. Dearborn; *Members of Council,* J. W. Gidley, Wm. Palmer, E. A. Goldman, Alex. Wetmore, H. C. Oberholser.

President Smith was nominated for Vice President to represent the Society in the Washington Academy of Sciences.

M. W. Lyon, Jr., *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

At the annual meeting of the Board of Regents of the Smithsonian Institution, held on December 12, 1918, Senator THOMAS, of Colorado, and Representatives FERRIS, PADGETT, and GREENE were elected to membership on the Board.

The Bureau of Fisheries, U. S. Department of Commerce, will build a new laboratory, estimated to cost $50,000, at Seventh and B Streets.

Experimental work at the American University Experiment Station, of the Chemical Warfare Service was discontinued on December 31, the most of the personnel having been transferred or discharged. A few of the officers remain to write up reports of the work of the Station.

Dr. N. L. BOWEN, of the Geophysical Laboratory, Carnegie Institution, has accepted the professorship of mineralogy at Queen's University, Kingston, Ontario.

Major General WILLIAM CROZIER, U. S. A., former Chief of Ordnance and later commander of the Northeastern Military Department at Boston, has been transferred to the retired list of the Army on his own application, after a service of nearly forty years.

Professor E. C. FRANKLIN returned to Stanford University, California, in December, after spending the greater part of the past year in research on the synthetic process for the fixation of nitrogen.

Dr. GEORGE E. HALE, of the National Research Council, and Prof. A. A. NOYES, of the Nitrate Committee, returned from England in December.

Mr. HENRY HINDS has resigned from the Geological Survey to enter the employ of the Sinclair Oil and Gas Company, at Tulsa, Oklahoma.

Lieut. HERBERT GRAHAM KUBEL, formerly cartographer with the U. S. Geological Survey, died on December 30, 1918. He left the position of acting chief engraver of the Survey in January, 1918, to receive a commission as first lieutenant in the Air Service. He was a member of the Society of Engineers.

Dr. H. A. LUBS has resigned from the Bureau of Chemistry, U. S. Department of Agriculture, to enter the employ of E. I. du Pont de Nemours & Company.

Prof. J. C. MERRIAM, of the National Research Council, returned to the University of California in December.

Professor JOJI SAKURAI, director of the newly established Institute of Physical and Chemical Research in Tokyo, Japan, visited Washington in December.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 9 FEBRUARY 4, 1919 No. 3

GENERAL SCIENCE.—*Science and the after-war period.*[1]

GEORGE K. BURGESS, Bureau of Standards.

Somewhat more than a year ago it was my privilege to address the Philosophical Society of Washington on the subject *Science and warfare in France*[2] in which I endeavored to indicate in some small measure the rôle science was playing in the war we all hope has just been brought to a close.

At this time, may we not consider the transition period into which we are entering and ask ourselves what will be the effect of war on science, the men of science, and in the relations of science to the community and the state? What are some of the lessons this war has taught? And what plans have been made here and elsewhere to apply them?

A scientific man would hardly be so rash as to pose as a prophet, yet he may, nevertheless, try to assemble and pass in review some of the tendencies of the time; and it is only by an intelligent examination of the underlying changes which are being produced in science and in its relation to society, that he is enabled to see his way ahead a little more clearly into the mist of the future; and he may thereby be enabled, at least in some small degree, to chart his course and take advantage of the various currents that have been set in motion by the war.

[1] Address of the retiring President of the Philosophical Society of Washington, presented before the Society January 4, 1919.

[2] Scientific Monthly, October, 1917.

The question may here be asked, can we not see from previous wars what this war will bring forth, or at least the broad lines along which progress will be made, in science and in its relation to mankind? But with what previous war shall we compare this? Surely not with the short Franco-German war of 1870 in which but two nations were engaged; if with the world-wide wars of the French revolution and Napoleon, we have a duration of twenty-five years as compared with four; and if any war prior to that epoch is considered, the development of science was hardly in a state to form a basis of comparison.

Again it may be asked, does war, did this war, stimulate scientific progress? Viewing the wealth of application of science in modern warfare, you will probably unhesitatingly say, *Yes*, but if you undertake to make a list of fundamental, new scientific principles developed as a war reaction I believe you will be embarrassed to name even a few of them; although there have been, of course, hundreds, nay, thousands, of applications of known scientific principles to new uses. It is still too soon, however, to estimate the scientific advance during the war and as caused by the war and such, even though I were competent, is not my purpose here. It will evidently be impossible to treat adequately the subject *Science and the after-war period* except in a most summary manner and I shall have to limit myself to certain phases in which I have been interested, paying particular attention to the physical sciences and the relation of science to industry.

SCIENTIFIC PRODUCTION

What is the effect of the war on scientific production, is not an easy question to answer. Many men have been killed, including a few who are scientific producers and many more young men who might have become distinguished in science; furthermore, not a few scientific centers have been destroyed. Thus viewed, there would appear to be a net loss to science in the world, but at the same time there have been stimulated to greater endeavor a considerable number of men of scientific ability and many new laboratories have been established. I believe that, for the

United States, the effect of the war will not have been detrimental to scientific production as our losses in young men of scientific attainments have been relatively insignificant, and also, I firmly trust, the country has in part learned the lesson of the advantage to the nation of generously supporting research.

For a country such as France, which has borne the brunt of the fighting for four years—and not until after the first battle of the Marne was any effort made to conserve her scientific men—the matter appears to be much more serious; but who dares to predict that the United States with nearly three times her population will lead France as a producer of original ideas in science a generation hence? It is well to remember that many of the master minds in science of the nineteenth century were born during the Napoleonic wars, and that it is quality and not quantity that counts in scientific progress.

Finally one may ask, is the after-war period to be one of great scientific activity or one of relative quiet, and what will be the lines along which development will take place? This brings us to a consideration of the nature and permanence of war activities in science. Never before have science and scientific men been used to such an extent both relatively and absolutely as the servants of war, both in the military establishments proper and in the not less important industrial supports. It is evident that what is beneficial in these relations should be maintained. In addition to the advancement in scientific knowledge, much of which is not yet generally available, brought into being by the war, there has also been worked out for war purposes, in a more or less satisfactory way, schemes of cooperation of scientific men with each other, with the state, with industry, and with the military establishment. Some of these are transitory in character, others are serviceable for both peace and war, and some have been devised especially for the after-war period.

One might perhaps expect a certain relaxation of effort, even among scientific workers, following the strenuous efforts of the war, but one must not forget the natural zest of the scientific man to get back to his chosen field which he will want to culti-

vate in his own way and not under the more or less arbitrarily imposed conditions of military requirements. Although much of the scientific work of the war has been done individually, probably by far the greater part has been by collective efforts of groups of workers usually under the guidance of some responsible committee or executive. Although this is no new phenomenon in scientific research, yet this cooperative method of attacking difficult problems has been, under the stress of war, developed to an hitherto unheard-of degree. It is probable that the naturally individualistic traits of scientific men will tend to cause a lessening of this type of common endeavor; although in the distribution of investigation, between groups or individuals, there will probably be a greater number of groups than before the war, the habit of working together having been fostered, and its advantages appreciated in certain cases. For scientific research carried out in the interest of industry, this group method will very likely be greatly developed.

STANDARDIZATION

One of the fundamental factors of the greatest economic importance, which the exigencies of the war have brought repeatedly to the fore both in battle and in workshop, is what one might almost call the crusade of standardization. This has taken on innumerable aspects and has constantly been recurring in conservation programs, economic production, and in the elimination of waste, time, materials, and men. The savings that may be accomplished by the scientific application of what we may call the principles of standardization in production, manufacture, and distribution of many, if not most, of the more usual commodities of commerce and industry is so great that I believe that it is not an exaggeration to say that by this means alone our national debt could soon be paid off, both interest and principal. An indication of what can be done along this line has been ably demonstrated in our own country by The War Industries Board and in particular its Conservation Division working in cooperation with the various industries.

This cooperation between Government and industry has been made most effective by the enforced revival of the guild organization in industry. The fact that an industry has been represented successfully as a whole during the war by an elected committee in treating with the Government and among themselves on matters of common interest, is charged with great possibilities for like action along voluntary lines during peace times. Although of course many of the questions thus treated may be considered as outside the realms of science, nevertheless the scientific man cannot be separated from this development, which, it is most urgently desired, may be continued, although along less arbitrary lines than were necessary in time of war.

SPECIFICATIONS

A closely related matter is that of preparing satisfactory specifications for materials and manufactured articles. Washington might almost have been called a specification factory during the past eighteen months. This is economically one of the most important of subjects and too great emphasis cannot be given to the desirability, not merely for materials of military interest but for all uses, of being able to define adequately and sufficiently—not too loosely nor yet too rigorously—the materials and articles that form the basis for practically all purchases. There have been, and still are in many fields, great confusion, uncertainty, and differences of opinion as to facts, and most of this is, in the last analysis, a result of ignorance of the scientific data regarding properties and materials on which the specifications are based. The nation has undoubtedly suffered untold losses on account of this ignorance, and endeavors should be made on a sufficiently comprehensive scale to eliminate as much as possible the waste arising from this cause.

Innumerable instances could be cited of the harmful and costly effects of too rigid specifications and of course we all know some of the dangers of too loosely drawn specifications. I will cite two of the former in my own field of metallurgy. A foreign government had a limitation, dating some thirty years back, of 0.05 per cent copper in a certain grade of munition steel

being made here. All the steel made from certain ores in this country necessarily carried four or five times the stipulated copper. Although at first insisting on the rejection of the steel, the government in question finally accepted it after overwhelming evidence was submitted showing that ten times the amount of copper was not only not detrimental but also of actual advantage in this steel. This single contract involved several millions of dollars; the total cost of all the experimental work ever done the world over on the effect of copper on steel would be at most a few thousands.

The second illustration is given by another government which desired to purchase steel here for aircraft parts with a phosphorus and sulphur content together of less than 0.03 per cent. They could buy no steel, and if they had been able to place an order it would have been at an exorbitant price. The fact that all the other allied countries were using a much less rigid specification with safety finally convinced them that theirs was too severe. Incidentally this latter case shows the evident advantages of interchange of ideas and experience in such matters.

Not a little of the delays in production of many materials for war purposes was due to the multiplicity of specifications insisted upon by the various independent purchasing departments of the Government. Some progress is being made toward unity in standardization and specifications in the War Department and it is highly desirable that there be constituted a central body with authority for all departments. A single board, for example, to frame metal specifications for all would make for economy and efficiency.

That the technical public is now ready for such simplification and uniformity is evident by the recent creation, somewhat on the British model, of the Engineering Standards Committee. The Germans are also said to be forming a similar organization and the French and Italian governments have organized standards committees. It is to be hoped that this is one of the after-war activities to be pushed. It is not too much to say we have entered an era of standardization. It is not necessary before a

group of scientific men, however it may be elsewhere, to state that standardization necessarily involves research, often very elaborate and costly.

INDUSTRIAL RESEARCH

The relation of science to industry has been a fruitful subject for discussion in recent years both here and abroad and nowhere has the question of industrial research, as it is often called, been cultivated more intensively and made more progress as a direct result of the war than in Great Britain; and it may be of interest to mention briefly some of the steps in the progress.

Following the economic congress of the Allied Nations at Paris, there was formed in July, 1916, a committee, presided over by Lord Burleigh, on commercial and industrial policy after the war, and the reports emanating from this body and its auxiliaries cover the whole field of the economic aspects—industrial, commercial, technical, and scientific—of the after-war period, and lay particular emphasis, for example, on the protection and development of "key" or "pivotal" industries, most of them requiring the highest grade of scientific and technical skill for their maintenance and advancement, such as synthetic drugs, optical glass, chemical glassware and porcelain, dyestuffs, magnetos, high explosives, etc.

It is of interest to note in passing that the questions of decimal coinage and the compulsory use of the metric system of weights and measures were also considered and their adoption not advised. The arguments advanced for this conservative stand, if valid, are of a nature that would seem to make it difficult ever to make the metric system universal. A transition period like the present has precedent for the establishment of such a simplification of units and standards; for the metric system originated during the French Revolution and the International Bureau was founded at the time of the war of 1870.

There has since been established in England a Ministry of Reconstruction to deal with the numerous problems the transition period presents. A Department of Scientific and Industrial Research with a Parliamentary Secretary has also been created

and has been active for nearly two years: (1) It has been encouraging firms in well-established industries to undertake co-operative study of the scientific problems affecting their processes and raw materials, and has at its disposal a sum of one million pounds for grants on the basis of an equal subscription from industry; (2) the Department has further prepared to undertake at the public cost investigations of general interest; (3) the importance to industries of the establishment of standards on a scientific basis is recognized and the financial control of the National Physical Laboratory has been taken over, with provisions for pensioning the staff, (4) efforts are being made to increase the numbers of trained research workers, which had reached a dangerously low ebb in 1915 as recognized by Lord Burleigh's committee, who found but forty qualified, unattached persons available for research in the United Kingdom

Very substantial results have already been achieved in these several fields and hardly a copy of *Nature* can now appear which does not record some new grant, technical committee, industrial research association, or other advance in the interdependence of science and industry under governmental supervision. It is also especially significant to note that some of the industries are also standing on their own feet and establishing their own research laboratories along cooperative lines.

There is also the recently founded British Science Guild with a distinguished membership which maintains lectureships and does much to foster the dissemination of the aims of research among the public.

This spirit of organized research has been contagious throughout the British Empire and there are being established similar associations, institutes, and laboratories in Canada, Australia, South Africa, and elsewhere.

Rather curiously in the democratic British communities, it is the Government that appears to be taking the lead in the stimulation of scientific research, particularly in its relation to industry. It is probable that the reasons for governmental initiative are in part a result of the abnormal conditions of the nation at war

during which time individual efforts are much more difficult of effective expression—the community in the time of danger is thinking and acting as a unit under military stress, and military methods predominate. As normal times return we may expect the state to relax its vigilance and the individual person, society, or industry to reassert to a greater degree their qualities of initiative and independence. It is not improbable, however, that there is a genuine conscious effort for the more generous support of research by the British public as a national asset, which support will be maintained in peace times on a much more extensive scale than in pre-war times.

UNION OF SCIENTIFIC WORKERS

Another incident significant of the trend of the times is the formation in October last of the British National Union for Scientific Workers with five hundred members whose main objects, most worthy of repeating here, are: (1) to advance the interest of science as an essential element of the national life; (2) to regulate the conditions of employment of persons of adequate scientific training and knowledge; (3) to secure in the interests of national efficiency that all scientific and technical departments in the public service, and all industrial posts involving scientific knowledge, shall be under the direct control of persons having adequate scientific training and knowledge.

The question that every scientific man in America naturally and perhaps unconsciously asks himself on hearing of such an organization is, of course, why not form such a union here? Indeed, the matter has been discussed in some centers and it would probably not be difficult to organize in the United States a similar union of scientific workers. Bodies somewhat similar already exist among various educational and professional groups. It should be borne in mind, however, in considering this matter that in addition to the general objects stated above, the scientific workers of England were almost compelled to organize in order to have representation on the so-called Whitley Industrial Councils, having to do with matters affecting labor and management relations in industry and one of the creations of the reconstruction program.

Forming what is perhaps the natural corollary to the foregoing, there has been some serious discussion in Britain of the desirability of having representatives of science as such in Parliament; certain of the universities have had representation for a long time but it is doubtful if the matter of representatives of science is pushed seriously. If science, why not literature, the arts, and so on?

While we are considering the question of the scientific man himself, there is one phase of his relation to science and to industry that I cannot pass by, which will need perhaps even more serious consideration in this transition period than it has had in the past. I refer to the bidding for his services by technical industries. A man who leaves the university or professional school and enters the research department of an industrial concern is not the man I mean. Is not the case different for a man who has chosen his career of scientific investigation in a university or other scientific institution independent of or under state control? This man, if taken from his environment by offers of financial gain, goes to enrich most certainly some special interest with his science and is still a valuable member of the community; but generally speaking, is it not of advantage to the community to keep that man contented in his, what I am tempted to call, more natural environment? Natural, for he chose it and adapted himself to it. When the staff of an institution of the character of the Geophysical Laboratory is in danger of being absorbed by industry, does not the matter become of serious concern? Should not the industries rather be encouraged to take their scientific men when they are young and not break up going scientific concerns? No doubt a certain amount of interchange in scientific personnel is to be encouraged but it should be interchange and not bleeding practiced by industry. Providing an adequate supply of scientifically trained men for the needs of industry, and defining the proper relations between industrial management and scientific centers, are questions meriting the most serious concern of the community. Our supply of scientifically and technically trained men is all

too meager and if, as many expect, there is now to be a period of expansion in the foreign trade of the United States involving possibly the establishment abroad of numerous branches of highly technical industries, the demand for such men will become more urgent than ever, particularly in the case of men of scientific training with engineering experience.

EDUCATION OF SCIENTIFIC WORKERS

This brings us to the question of the education of scientific men, which subject it is possible to mention but briefly. Here again the interruption, disorganization, and readjustment of educational training in America have been insignificant as compared with the disturbances in education brought about by the necessities of war of the European countries, but even in this country experiments with intensive training and shortened courses have been tried on a large scale but, it must be borne in mind, for a limited period only. Our educational institutions will undoubtedly be able to preserve some of the beneficial characteristics brought out by such speeding up but for the most part there probably will be little effect on the kind of training our scientific men will get.

It would appear to be highly desirable that as large a proportion as heretofore of our scientific men pass a portion of their preparative period abroad amid cultural surroundings different from those in which they grew up. As a beginning it is to be hoped that many of our young men now in France will be given the opportunity to take advantage of the generous offer of the French Government for instruction in the schools and universities of France. This if carried out on a considerable scale, will have far-reaching effects, the benefits of which can hardly be overestimated. It is also to be hoped our universities will not only encourage the coming of foreigners more than heretofore but also render easier the migration of American students from one American institution to another. The establishment in Washington of schools framed on lines similar to the "Ecole des Hautes Etudes" and the "College de France," which are devoted exclusively to research would go far toward making more gener-

ally available the research facilities and scientific men of the capital.

During the war the scientific men of the country have been thrown into close association with each other, perhaps even closer in many instances than in pre-war times in spite of the decrease of attendance at scientific meetings and in the number of such meetings; in addition, there have been developed, as never before, acquaintance and cooperation of the men of science of this and the allied countries; and not only the men of one science have been thrown together but representatives of what we ordinarily consider very diverse sciences have been brought into close personal and professional contact. All this makes for the unity of science and the broadening of scientific men. It would seem desirable to make an effort to perpetuate this habit of association of scientific men from different countries. You will recall that in 1914 there were projected several international congresses in science and engineering. Would it not be well, as soon as circumstances permit, at least to revive these projected congresses with such limitations as comply with the conclusions reached recently in London by representatives of the National Academies of the Inter-Allied Nations?

SCIENTIFIC PUBLICATIONS

A very important matter, that has been held generally in abeyance by the war, which will soon again require the serious attention of scientific gatherings, is that of the policies regarding scientific publications. Very definite proposals have been discussed recently in England looking particularly to the avoidance of duplication, confusion, and other anomalies in scientific literature and to its more effective distribution. This question again is a variant of the standardization problem and is further complicated by interests or prejudices, both national and professional, of numerous societies representing often, if not competing, yet overlapping fields of science. For any particular branch of science, there are also the international aspects to be considered including the question of language; and it is within the bounds of possibility, for example, that there will occur a

revival of the more concerted efforts for the use of an auxiliary international language such as Esperanto, or, if you will, some standardized international form of expression in science.

If I have dwelt with less emphasis on some of the recent, strictly American tendencies of scientific development, I trust it fair to assume you are acquainted with most of them. The great work of the National Research Council is certainly familiar to us all and it is good news to hear that plans are being developed toward reorganizing the Council to meet the conditions of the reconstruction period. There is great need in the United States, with our relative geographical isolation and great distances between many scientific centers, for an active scientific body devoted to the initiation, stimulation, and correlation of scientific research.

Furthermore, by emphasizing the recent British developments in the relations of state, industry, and science, I by no means desire to imply that we have not been active in America. These matters are being freely discussed here and many plans are being formulated, and some are in operation, for cooperative research in various branches of science particularly as applied to industry. The weekly and monthly scientific press are full of them. It is to be noted that in contrast with the British experience, in America less expectation is being placed on governmental aid to new research projects; an exception to this is, of course, the Smith-Howard bill now before Congress for promoting engineering research in the several states.

CONCLUSIONS

In America, individual initiative in the past has on the whole been more potent than the state in providing the funds for maintaining research. In the prosecution of the war now drawing to a close, however, the Federal Government has spent huge sums on projects requiring scientific investigation and development, and, in order to carry out the scientific projects of military urgency, has mobilized the scientific men of the country. Is it well during the after-war period to demobilize completely this army of scientific men? No one would yet think of having

no organized military force in peace time, and there is in every well-organized state always at least a skeleton army with all branches represented, including a competent staff, arsenals, depots, surplus munitions, and supplies.

The great scientific bureaus of the Government are organized for the problems of peace and, although they can give a good account of themselves under war conditions, yet would it not be well, at least until the millennium is more clearly in sight, to retain more than a nucleus of an organization of scientific men in the service of the state and especially in the military and naval establishments? We can all name branch after branch of each of these services which before the war contained almost no scientific personnel but to which have been added during the war scores and hundreds of scientific men; and in some cases it was no easy matter to gather and coordinate this personnel.

What therefore appears to me as one of the very important problems of the transition period, namely the proper balancing and distribution of the scientific forces of the country as between the military and civilian activities of the state on the one hand, and the industrial and academic activities of the country on the other, is even now undergoing the process of being solved. The readjustment will go on largely unperceived at the moment, and the changes will be accompanied by the usual quiet but significant struggles. The more rapidly the world settles down to more stable conditions, the more promptly will we reach this dynamic equilibrium of the distribution of scientific men and the balancing of competing fields in scientific research.

GEOLOGY.—*Lower Cretaceous age of the limestones underlying Florida.*[1] JOSEPH A. CUSHMAN, Sharon, Massachusetts. (Communicated by T. W. Vaughan.)

A study of the Foraminifera of well borings from a number of the deeper wells of Florida has proved of more value than was at first expected. Some of these wells reach depths not heretofore penetrated in this area. The wells giving the most important results and their depths are as follows:

[1] Published by permission of the State Geologist of Florida.

Near Burns, Wakulla County; 2,153 feet.
Jacksonville, Duval County; 980 feet.
St. Augustine, St. Johns County; 1,440 feet.
Anthony, Marion County; samples from 50–500 feet.
Eustis, Lake County; samples from 100–180 feet.
Bushnell, Sumter County; samples from 380–3,080 feet.
Apopka, Orange County; samples from 50–390 feet.
Sanford, Seminole County; samples from 95–113 feet.
Cocoa, Brevard County; a sample from 190 feet.
Tiger Bay, Polk County; 770 feet.
Okeechobee, Okeechobee County; samples to 500 feet.
Fort Myers, Lee County; 950 feet.
Marathon, Key Vaca, Monroe County; 2,300 feet.

The examination showed many Foraminifera, among which were two species of the genus *Orbitolina* occurring at different levels. One of these, a small conical species, is encountered at much higher levels than the other which is a large, low, somewhat concave species. The first of these is very close to, or identical with, a species of *Orbitolina* known from the Quitman Mountains of Western Texas, where it characterizes a horizon of the Fredericksburg group of the Lower Cretaceous. A species seemingly identical is found in the Lower Cretaceous of the Province of Navarra in northern Spain. Other species of different groups, echinoderms, etc., are identical in Spain and northern Mexico in the Lower Cretaceous.

Below the Fredericksburg in the Quitman Mountains, in the same section, in the Trinity group of the Lower Cretaceous are horizons marked by great numbers of *Orbitolina texana* which is seemingly identical with the larger species of the Florida well borings and found only at some depth below the conical species. In the borings accompanying these species are others that are close to Lower Cretaceous species of Europe.

The limestone characterized by these species of *Orbitolina* seem to underlie practically the whole of the peninsula of Florida, being found in the wells at the north near Burns, Jacksonville, and St. Augustine, in the well at the south on Key Vaca, and in the central region at Anthony, Eustis, Bushnell, Apopka, and Tiger Bay.

Assuming the altitude above sea level at Apopka as 150 feet,

the Lower Cretaceous stands 35 feet above present sea level, for the conical *Orbitolina* appears in the well borings 115 feet below the surface. From similar data it appears to be 33 feet below sea level at Anthony and less than 100 feet below sea level at Eustis.

At other localities, it is 400 feet below sea level at St. Augustine, 820–845 feet at Jacksonville, 500 feet at Tiger Bay, and 1,248 feet at Marathon. Assuming an even rate of slope and that the conical *Orbitolina* is confined to a single horizon, this gives a dip southward from Apopka to Tiger Bay of about 9 feet to the mile and from Apopka northeastward to St. Augustine of about 6 feet to the mile. A low anticline is thus indicated with its center somewhere in the general region of Apopka.

On the upper surface of this Lower Cretaceous limestone the upper Eocene is represented by the Ocala limestone and in part at least by the Claiborne. The borings indicate that this contact is unconformable, because there is no Upper Cretaceous present in any of the well samples that were examined. This may be due to deposition and subsequent erosion or to the area being a land mass at this time. As the Washita, or upper group of the Lower Cretaceous, is unrepresented so far as can be seen, this group, if deposited, may have been eroded during Upper Cretaceous time while the whole area was elevated to a slight degree, the elevation having taken place, as in other regions, at the end of Lower Cretaceous time. The structure indicates this possibility rather than that the whole series was deposited and subsequently was entirely removed by erosion. It seems then that the area must have been a land mass during Upper Cretaceous and early Eocene time.

The Ocala and Claiborne are not represented, as far as the samples show, at Apopka and this area may have been an island during the deposition of the Ocala.

Where the typical Ocala is developed it seems to be only about 40 feet thick instead of the much greater thickness usually assigned to it. The fossils of the Ocala are brought up from lower levels but are evidently specimens that have dropped down from higher levels during the drilling. A bed of peculiar

Nummulites characterizing the Claiborne occurs just below the Ocala and makes an excellent criterion for delimiting that formation. The Ocala also dips to the northeastward and to the south from the Apopka region.

From the present occurrence of the Ocala above sea level in west central Florida and its occurrence in the Tiger Bay and St. Augustine wells at 360 and 224 feet, respectively, below the surface, a dip somewhat like that of the Lower Cretaceous is indicated.

The general conclusion from the evidence of the Foraminifera is that the whole of the Florida peninsula and probably a part of north Florida as well, as indicated from the data near Burns, are underlain by rocks of Lower Cretaceous and perhaps older age and that on the Lower Cretaceous the upper Eocene beds were deposited. The area was probably uplifted at the end of the Lower Cretaceous and remained a land mass during Upper Cretaceous and early Eocene time, after which it was again depressed and except in the region of Apopka was under water during the deposition of the Ocala limestone in late Eocene time.

EPIDEMIOLOGY.—*A contribution to quantitative epidemiology.* ALFRED J. LOTKA, New York City.

In his recent paper on Pathometry[1] Sir Ronald Ross develops, for a certain class of cases, the equation

$$F_{t,o} = A/P \int_0^\infty c\, F_{t,s}\, ds. \qquad (1)$$

In this equation $F_{t,s}\, ds$ denotes the number of cases which at time t have been affected for a length of time comprised within the limits of s and $s + ds$; $F_{t,o}$ is accordingly the rate at which new cases are developed at time t. The total population is P, the unaffected population A, while c is the coefficient of infectivity.

A solution is given by Sir Ronald Ross, among other things, for the special case that the coefficient of infectivity c is inde-

[1] Proc. Roy. Soc. 93: 235.

pendent of the "duration" (age dated from inception) of the case, and that $F_{t,s}$ is constant, namely

$$F_{t,s} = F_{t,o} \tag{2}$$

over the range defined by

$$q_1 < s < q_2 \tag{3}$$

while

$$F_{t,s} = 0 \tag{4}$$

outside of this range.

A solution can still be obtained, as indicated below, if we abandon these restrictions,[2] retaining only the following assumptions:

1. Immigration and emigration are negligible.

2. The affected population is always a small fraction of the total and, the total population being given as constant, the unaffected population also may therefore be considered as practically constant.[3]

3. The coefficient of infectivity c, though a function of the duration s, is independent of t. This is equivalent to saying that the infectivity of the disease varies in each affected person according to the "age" (duration) of the case, but is the same function of this age from case to case, at all times.

Equation (1) is then of the form

$$F_{t,o} = K \int_{q_1}^{q_2} c\ (s)\ F_{t,s}\, ds. \tag{5}$$

[2] We shall, however, retain the condition expressed in Equation (4). This is virtually no restriction at all since q_1 and q_2 in (3) may be given any values from o to ∞, and in practice the duration of the disease is always limited to finite time. At most the condition (4) might be construed as excluding infection by nonaffected carriers.

[3] In the notation of Sir Ronald Ross's paper we have, in fact, in this case $\frac{A}{P} = \frac{P-Z}{P} = 1$ since Z, the affected population, is small as compared with P, the total population. The coefficient K which occurs in (5) and subsequent equations is thus practically unity.

The case is here analogous to that of certain chemical reactions in which one of the reacting substances is present in large excess, as for instance water, when used as a solvent for the reacting substances in dilute solution, and when itself consumed or formed in the process. The concentration of the water in such cases may be regarded as practically constant.

It will be convenient to adopt a somewhat different notation to designate $F_{t,s}$ the "survivors" at time t, "of duration s," out of the original batch $F_{t,o}$ of new cases.

If we denote by $F(t)$ the new cases per unit of time at time t, and consequently by $F(t-s)$ the new cases per unit of time at time $(t-s)$, then let $F(t-s)\ p(s)$ denote the survivors at time t of the new cases per unit of time which originated at time $(t-s)$. Evidently the relation between this notation and that in the original paper referred to above is

$$F_{t,s} = F(t-s)\ p(s). \tag{6}$$

In this notation (5) becomes

$$F(t) = K\int_{q_1}^{q_2} F(t-s)\ p(s)\ c(s)\ ds \tag{7}$$

which, in view of (4), may indifferently be written

$$F(t) = K\int_{o}^{q_2} F(t-s)\ p(s)\ c(s)\ ds. \tag{8}$$

The integral equation (8) is of the type dealt with by Hertz.[4] To solve it we must know the value of $F(t)$ from $t = o$ to $t = q_2$, or what is the same thing, the number of cases at every "age" (duration) between o and q_2 at time $t = o$. We may leave out of account the number of cases of "age" (duration) above q_2 at time q_2, since they have ceased to be infective.

We have then by Hertz

$$F(t) = \sum_{h=1}^{h=\infty} \frac{e^{u_h t}\int_o^{q_2}\left\{F(s) - K\int_o^{s} p(s_1)\ c(s_1)\ F(s\,s_1)\ d{-}s_1\right\} e^{-u_h s}\ ds}{K\int_o^{q_2} s\ p(s)\ c(s)\ e^{-u_h s}\ ds}$$

Where $u_1, u_2 \ldots$ are the roots of the equation for u

$$1 = K\int_o^{q_2} p(s)\ c(s)\ e^{-us}\ ds. \tag{10}$$

[4] Math. Ann. 65: 86. At the same time, it will also no longer be warranted to make the assumption (implied in a constant population) that the death rate is not appreciably affected by the progress of the disease (unless indeed the disease is never fatal). Moreover, if a large proportion of the population has become affected, the unaffected portion of the population will in practice be inherently different in character from the total population. It will contain a larger proportion of persons of low "susceptibility." So long as the number of persons affected forms but a small fraction of the total population, we may neglect this "selective" effect, as has been done above. But with a large "affected" proportion of the total population this neglect is no longer justified.

From the nature of the case q_2, $p(s)$, and $c(s)$ are never negative. It follows that (10) has one and only one real root U, which is $\gtreqless$ 0 according as

$$K \int_0^{q_2} p(s)\, c(s)\, ds \gtreqless 1\,. \qquad (11)$$

It can easily be shown that any other root must have its real part less than U.

It follows that for large values of t the term with the real root U outweighs all other terms in (9), and $F(t)$ approaches the value

$$F(t) = F(0)\, e^{Ut}\,. \qquad (12)$$

Furthermore,

$$F(t-s) = F(0)\, e^{U(t-s)} \qquad (13)$$

and

$$F_{t,s} = F(t-s)\, p(s) = F(0)\, e^{U(t-s)}\, p(s) \qquad (14)$$

The function $F_{t,s}$ is thus determined.

For $Z(t)$, the total number of cases existing at time t, we have by Equation 86 of Sir Ronald Ross

$$Z(t) = \int_0^\infty F(t-s)\, p(s)\, ds \qquad (15)$$

$$= F(t) \int_0^\infty e^{-Us}\, p(s)\, ds \qquad (16)$$

$$= C\, F(t) \qquad (C = \text{const.}) \qquad (17)$$

since we are assuming that $p(s)$ is independent of t; and hence by (12)

$$Z(t) = C\, F(0)\, e^{Ut} \qquad (18)$$

$$= Z(0)\, e^{Ut} \qquad (19)$$

that is to say, the affected population increases in geometric progression with the time, at the same proportional rate as do the new cases per unit of time.

In practice, if this state of affairs persists, a time must be reached when, with a constant total population, the affected population can no longer be regarded as a small fraction of the total, and when, therefore, the solution here given no longer applies.[5]

One point deserves special notice. It will be observed that since U is determined by Equation, (10), it is wholly independent

[5] See footnote 4.

of the subsequent fate of the affected persons after they pass beyond the period $q_1\, q_2$ of infectivity, or of their condition before they enter it, provided only that they enter it with a given value of $p\ (q_1)$. This may appear at first sight somewhat surprising, but on reflection is found to be in accord with reason.

The case discussed above is strictly analogous to the "Problem in Age-Distribution" which has been treated by Prof. F. R. Sharpe and the writer elsewhere.[6] The development given above is what the present author had in mind when he wrote, in a previous publication:[7]

> Brief reflection shows that we can apply to this case (endemic disease) a mathematical treatment precisely analogous to that of the growth of a population; for we may think of the diseased portion of the population as a separate aggregate, into which new individuals are recruited by fresh infections, just as new individuals enter an ordinary population by procreation. On the other hand, members are continually eliminated from the aggregate, first by deaths, secondly by recoveries. On the basis of these considerations formulae can without difficulty be established between the factors enumerated above. Such general formulae, however, involve certain functions which are unknown, and the determination of which by statistical methods would at best present great difficulties.

In conclusion it may not be out of place to remark that, aside from mathematical similarity, what places the two cases—growth of a population and spread of a disease—in the same class, is the physical circumstance that both are cases of autocatalytic or autocatakinetic growth. The rate of growth at any instant increases with the size of the existing nucleus or focus, other things equal.

[6] See also SHARPE and LOTKA. Phil. Mag., Apr. 1911, p. 436.

[7] Nature, Feb. 8, 1912, p. 497.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors The abstracts should conform in length and geneial style to those appearing in this issue

PHYSICAL CHEMISTRY.—*The color of inorganic compounds.* F. RUSSELL V. BICHOWSKY. Journ. Amer. Chem. Soc. 40: 500–508. March, 1918.

It is shown that every valence state of an element can be associated by means of purely experimental evidence with a definite "atom color." There is a marked relation between atom color thus determined and valence and valence variability. The atom color of every element in its normal valence state, that is, in the valence state which corresponds to its place in the periodic system, is zero (all nonvariant-valence atoms have their normal valence). The atom color of an element, in valence states where the valence is decreased or increased by an odd number from the normal valence, lies further in the blue than the atom color of the same element in any other valence state. The atom color of an element in a state whose valence is removed by an even number from normal will be zero if compounds of the element do not exist in which the valence of the element is removed by an odd number from normal; otherwise the atom color will lie further in the yellow than the atom color of the same element in a state of valence removed by an odd number from normal. Compounds between nonvariant-valence elements will be colorless. Compounds between a nonvariant-valence element and a variant-valence element will have the same color as the "atom" of variant-valence element. Compounds between other elements will have colors more to the blue than the sum of their atom colors. All these regularities can be deduced from a variation of Lewis's theory of atom structure. The almost perfect accord between the deduction and the facts indicates very strongly that Lewis's fundamental hypotheses are correct. F. R. B.

INORGANIC CHEMISTRY.—*The equilibrium between carbon monoxide, carbon dioxide, sulfur dioxide, and free sulfur.* JOHN B. FERGUSON. Journ. Amer. Chem. Soc. 40: 1626–1644. November, 1918.

This paper contains an extended account of the investigation of the reaction $CO + {}^1/_2SO_2 \rightleftarrows CO_2 + {}^1/_4S_2$, a partial summary of which appeared last year. The study was undertaken primarily as a part of a comprehensive study of certain gas reactions and their rôle in volcanic activity, and this particular reaction was selected because it afforded a direct means of determining the free energy or thermodynamical potential of sulfur dioxide, one of the most important of the volcanic gases.

The composition of the equilibrium gas mixtures obtained, with the corresponding initial gas mixtures, both calculated and actual, and the resulting equilibrium constants, are given in tabular form and the thermodynamical calculations based thereon given in detail. The latter give an average mean value of 3.99 for the thermodynamical constant I and − 22510 calories for the change in free energy for the reaction under standard conditions. For the reaction $S_R + O_2 \rightleftarrows SO_2$ under similar conditions, the value for the change of free energy is − 69761.

R. B. SOSMAN.

ENTOMOLOGY.—*Memoirs on the Coleoptera VIII.* THOMAS L. CASEY. New Era Printing Company, Lancaster, Pa. November 12, 1918.

In this volume the author reviews several large subfamilies of the Carabidae or ground beetles. A very large number of new species and subspecies are described, especially in some of the groups of the Bembidiinae and in the *Celia* and *Amara* of the Amarinae. A résumé of the American genera and subgenera of the Pterostichinae is given in some detail. There can scarcely be a doubt that all the forms enumerated have at least some taxonomic standing, although the true interrelationship of the various units is a problem that cannot be solved except in many years of careful study.

There are two passably definite methods in the investigation of natural groups in the Insecta, so far as the delimitation of species is concerned. One of these methods, which is more especially developed among the German investigators, constantly bears in view the overlooking of differences, in order to reduce specific forms to the smallest

possible number. The other, which might be regarded as more essentially the French system, carefully records differences, whether of structure or facies, and endeavors to formulate a taxonomic scheme in accordance therewith. One system is based more especially upon resemblances, the other upon differences. Either system when carried to an extreme must involve mistakes, though knowledge as a whole is more likely to be advanced by the second than by the first of these systems. The author of the present volume inclines to the French system, which apparently is also preferred by most of the English investigators. T. L. C.

APPARATUS.—*Temperature uniformity in an electric furnace.* JOHN B. FERGUSON. Phys. Rev. 12: 81–94. July, 1918.

The problem of temperature uniformity in an electric furnace is intimately connected with almost all investigations carried on at high temperatures. For this reason it has generally been considered as a part of a larger problem and has been solved to the extent demanded by the requirements of the work at hand. In this paper the writer presents a more general discussion of the subject, together with many results obtained by him in his various investigations bearing directly thereon. The production of temperature uniformity in an electrically heated air column may best be done by means of three independent heaters and end plugs. R. B. S.

APPARATUS.—*Thermal leakage and calorimeter design.* WALTER P. WHITE. Journ. Amer. Chem. Soc. 40: 379–393. February, 1918.

The interchange of heat between a calorimeter and its environment (thermal leakage) is practically proportional to their temperature difference, except for the effect of evaporation and for that of convection, which is, for ordinary calorimetric conditions, more nearly proportional to the square of that difference. If evaporation is suppressed the advantages of a constant thermal leakage factor are obtained by preventing convection. Recent investigations upon convection show how this may most advantageously be done. In adiabatic work there is little fear of convection, hence either very large temperature intervals or very large air gaps can be profitably employed. Incidentally, it is pointed out that the ordinary rule, that thermometric lag causes no error where only one thermometer is used, deserves careful interpretation, or else restatement, in the case of some thermochemical determinations. R. B. S.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

At the meeting of the Board of Managers on January 10, 1919, it was voted to turn over the accumulated exchanges and miscellaneous publications owned by the ACADEMY to the Librarian of the Smithsonian Institution, with the request that he first complete the files of the Institution where possible, and then distribute the remainder in whatever manner will make the publications most useful to scientific libraries.

The following persons have become members of the ACADEMY since the last issue of the JOURNAL:

Mrs. AGNES CHASE, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

Mr. JOHN BRIGHT FERGUSON, Geophysical Laboratory of the Carnegie Institution of Washington, Washington, D. C.

Mr. MORRIS HACKER, District Building, Washington, D. C. (Nominated as Vice-President by the Washington Society of Engineers.)

Dr. EUGEN W. POSNJAK, Geophysical Laboratory of the Carnegie Institution of Washington, Washington, D. C.

Mr. SIEVERT ALLEN ROHWER, Bureau of Entomology, U. S. Department of Agriculture, Washington, D. C.

ROBERT B. SOSMAN, *Corresponding Secretary.*

THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

The 318th regular meeting of the Society was held in the hall of the Carnegie Institution, January 8, 1919. There were present 32 members and 5 visitors.

The President read the following list of members of the Society who have been in the military service: Captains D. L. VAN DINE, A. H. JENNINGS, J. D. HOOD, E. H. GIBSON, and G. F. WHITE; Lieutenants W. H. WHITE, L. H. DUNN, and E. W. SCOTT; Sergeant R. C. SHANNON, and Privates WM. MIDDLETON and C. A. WEIGEL, while Dr. O. H. BASSECHES was in training camp at the signing of the armistice. Of these Captain A. R. JENNINGS has died in the service. The President appointed Dr. W. D. PIERCE, Mr. AUGUST BUSCK, and Dr. A. G. BOVING as a committee to draw up a memorial and prepare a bibliography of Captain JENNINGS.

The regular program was as follows:

E. R. SASSCER: *Hydrocyanic-acid gas and its use in the contorl of insects.* (Presidential address.) This paper dealt with the history of the use of hydrocyanic-acid gas in the control of insects. Reference was made to its discovery in 1872 by Scheele and its early use as an insecticide in California in 1886 by D. W. Coquillett. Brief reference was made to the occurrence of hydrocyanic acid in nature, indicating that in addition to its occurrence in the secretion of certain myriapods, it is also found in the seed, foliage, or bark of certain plants, thirty-odd plants being listed which contain the acid in nature.

After discussion of the preparation of hydrocyanic-acid gas as used against insects, a brief history of its use against the following was given: Citrous Insects, Greenhouse Insects, Mill and Stored Product Insects, Nursery and Deciduous Fruit Insects, Household Insects and Sanitation, and Soil Insects.

Brief mention was made of the effect of this gas on the germination of seed. Also the effect of the gas on insects and man was given consideration.

The reading of the address was followed by lantern slides showing the development of the apparatus used in the fumigation of citrous trees and the vacuum process of fumigating nursery stock and bale cotton.

The address called forth a lively discussion. Mr. Schwarz stated that he had first used cyanide of potassium in his killing bottles about 1868, and that he had seen it used as an insecticide for the protection of crops as early as 1879. This was in a small vineyard in Texas, the owner surrounding his vineyard with a belt of cyanide of potassium solution to protect it from the ravages of leaf-cutting ants. Immense numbers of the ants were killed in attempting to cross the poisoned ground.

Dr. Quaintance recalled the remarkable activity in the development of insecticide work at about the time hydrocyanic-acid gas was first used. Mr. Hutchison spoke of the experimentation with war gases as insecticides and of the great success attending the use of some of them.

As a possible explanation of the difficulty of killing certain insect larvae, Dr. Böving explained the mechanism of the closing apparatus in the tracheae.

Notes and exhibition of specimens: Mr. Schwarz commented on the fact that an Australian lady-bird beetle which has stood in the literature as *Vedalia koebelei* Blackburn has never been described by Blackburn, but the preparatory stages were described by Coquillett in such manner as to fix the species, which must, therefore, be known as *Vedalia koebelei* Coquillett. Dr. Quaintance mentioned the case of the recently described Californian apple *Coleophora,* which through delay in the publication of its description by Heinrich, its real author, and the description of it in an economic paper by W. D. Volcke, must be known as *Coleophora volckei* Volcke, placing Mr. Volcke in the position of naming a species for himself. Other examples of this were cited by Dr. Howard, Mr. Schwarz, and Mr. Caudell.

Mr. Hutchison exhibited photographs showing method of rearing body lice for experimental purposes.

R. A. CUSHMAN, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

Captain Howard E. Ames, Medical Director, U. S. N., Retired, died on December 27, 1918. Dr. Ames had been an officer in the Navy since 1875, and had been on the retired list since 1912. He served as medical officer on board the *Bear*, which rescued General Greely and his party in the Arctic regions. He was a member of the Biological Society.

Mr. Andrew Braid, hydrographic and geodetic engineer of the U. S. Coast and Geodetic Survey, and chairman of the U. S. Geographic Board, died on January 3, 1919, in his seventy-third year. He was a native of Scotland, and had been in the service of the U. S. Government since 1869. He was chief of the instrument division for several years, and was in charge of the standard weights and measures of the United States during the years just preceding the establishment of the Bureau of Standards.

Dr. Keivin Burns of the Division of Optics, Bureau of Standards, is absent on an extended trip abroad in connection with his scientific work.

Col. G. A. Burrell, of the Chemical Warfare Service, returned to private chemical engineering work at Pittsburgh in January. He was called to Washington by the Bureau of Mines early in the war, to take charge of the research organization that later became the American University Experiment Station of the Chemical Warfare Service.

Mr. Alonzo Howard Clark, curator of the division of history of the National Museum, and editor of publications at the Smithsonian Institution, died on December 31, 1918, in his sixty-ninth year Mr. Clark was born at Boston, Massachusetts, April 13, 1850. He had been with the Smithsonian Institution since 1881. He was the author of several publications on the fishery industries of the United States, and was a frequent contributor to historical and genealogical periodicals.

Dr. G. W. Coggeshall has resigned from the Emergency Fleet Corporation and has returned to the Institute of Industrial Research.

Dr. A. S. Cushman has been honorably discharged as Lieutenant Colonel, Ordnance Department, U. S. A., and has returned from Frankford Arsenal, Philadelphia, to resume his former duties as director of the Institute of Industrial Research.

Mr. John Gaub, in charge of the laboratories of the Filtration Plant, has resigned to become Health Officer and Examiner of Foods at Montclair, New Jersey.

Dr. D. R. Harper, 3rd, physicist at the Bureau of Standards, and engaged in the personnel and employment work of the Bureau during the war, resigned at the close of the year and has joined the staff of the U. S. Bureau of Efficiency, where he will assist in the reorganization and expansion of the Internal Revenue Service.

Mr. M. D. Hersey of the Bureau of Standards recently returned from an extended trip abroad. He spent several months in England, France and Italy, conferring with officials there in regard to the development of aeronautic instruments.

Professor A. S. Hitchcock, of the Bureau of Plant Industry, is chairman of the Committee on Nomenclature of the Botanical Society of America.

Mr. Neil M. Judd, of the department of anthropology, Smithsonian Institution, has been appointed curator of American archeology in the National Museum.

Dr. Paul D. Merica, associate physicist in the metallurgical division of the Bureau of Standards, has resigned from the Bureau and is with the International Nickel Company at Bayonne, New Jersey.

Dr. P. W. Merrill has resigned his position at the Bureau of Standards to take up scientific work at the Mt. Wilson Solar Observatory of the Carnegie Institution of Washington, at Pasadena, California.

Professor C. K. Leith, professor of geology at the University of Wisconsin, and member of the Shipping Board, sailed for France early in January to join the American peace delegation.

Dr. Wallace Clement Sabine, professor of physics at Harvard University, died at his home on November 11, 1918. He had been located in Washington during the war as Director of the Section of Technical Information of the Bureau of Aircraft Production.

Professor T. T. Smith of the University of Kansas, who has been in charge of the work on optical instruments and the testing of optical glass at the Bureau of Standards for the past year, has returned to the University.

Mr. H. F. Staley, formerly professor of ceramic engineering at Iowa State College, joined the staff of the Bureau of Standards in December as metallurgical ceramist. Mr. Staley had been engaged in war research at the Bureau since June, 1918.

Lieut. D. L. Webster, formerly with the National Research Council, has returned to the department of physics of the University of Michigan.

Dr. Edgar T. Wherry, of the Bureau of Chemistry, U. S. Department of Agriculture, has been appointed editor-in-chief of *The American Mineralogist*. Among the associate editors is Dr. W. T. Schaller, of the U. S. Geological Survey.

Major F. E. Wright, of the Ordnance Department (formerly of the Geophysical Laboratory, Carnegie Institution), has been elected president of the Optical Society of America.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 9 FEBRUARY 19, 1919 NO. 4

APPARATUS.—*An apparatus for growing crystals under controlled conditions.* J. C. HOSTETTER, Geophysical Laboratory, Carnegie Institution of Washington.

Crystals, to be suitable for the study of the effects of pressure, must be perfectly developed and of comparatively large size. The criterion of perfect development, in this case, is not in the possession by the crystals of those rare faces that so delight the crystallographer, but in the possession of maximum strength. In general, it may be said that the causes which diminish the transparency of those crystals that are normally transparent, also decrease the strength of the crystals. Perfect transparency in a crystal results only when the rate of growth is small and constant, or nearly so, throughout the entire growing period. Nontransparency in a crystal (except that due to the inclusion of foreign solids), is usually indicative of suddenly increased growth rate with the attendant development of cleavage planes and, frequently, inclusion of mother-liquor. For growing crystals that are suitable for pressure studies there is required, therefore, apparatus in which *all* variables affecting rate of growth are under control. The degree of supersaturation in the mother liquor at any time determines the increment of growth;[1] consequently, the conditions affecting supersaturation—primarily,

[1] While this is generally true there are certain important exceptions which cannot be adequately explained at the present time. An interesting case is that of gypsum described by W. J. FAWCETT, Proc. Roy. Soc, Canada 7: 218. 1913.

temperature and evaporation—must be under definite control. Of lesser importance—but nevertheless, essential—are the direction of concentration currents, and the number of crystals which serve as nuclei for growth. When these variables are controlled it is not a difficult task to grow very perfect crystals of large size.

In this note we will confine ourselves to the growth of soluble substances from solution, and merely mention the growth of very slightly soluble substances in crystal form, which has been developed very thoroughly,[2] and the growth of crystals from melts.[3]

Neglecting the effects of hydrostatic pressure, it may be said in general that there are four methods of producing supersaturation in a saturated solution and, hence, growth of a crystal immersed therein. In a solution saturated with respect to a certain crystal phase at a definite temperature we may produce supersaturation by (1) lowering (or, in rare cases, raising), the temperature, (2) allowing the solution to evaporate, (3) dissolving in this solution held at constant temperature, extremely finely divided particles of the crystalline phase, or (4) adding another solvent in slight amount.[4] It is quite evident that a crystal-growing apparatus based on any, or a combination of all, of these principles will be satisfactory if the variables are properly controlled, but in most of the crystal-growing devices described in the literature, the governing of some of the essential conditions has been left entirely to chance. Practically, devices based on temperature change are easier to control and, probably, the most easily constructed. The apparatus finally developed and described below is based on this principle.

[2] Almost all methods for the growth of "insoluble" precipitates in crystal form are based on diffusion processes. For a discussion of the essential conditions see JOHNSTON. Journ. Amer. Chem. Soc. 36: 16. 1914.

[3] R. NACKEN has recently described apparatus for growing crystals from melts; but the crystal nucleus is supported on a wire which becomes enclosed by the crystal as growth proceeds. (Neues Jahrb., 1915, II, 145.) Such crystals are, for this reason, not suitable for pressure studies.

[4] As alcohol to an aqueous solution of a sulfate.

To the essential conditions previously discussed we must add another if the crystal-growing process is to be continuous; namely, that the supersaturated solution must be given definite circulation over the nuclei to be developed. Recently a crystal-growing apparatus with controlled circulation has been patented by Krüger and Finke.[5] In this apparatus the mother-liquor is saturated in one chamber and then passed into another chamber of lower temperature where deposition takes place on the crystal nuclei to be grown; the solution is then returned to the saturating vessel. This patent of Krüger and Finke furnished the basis for the apparatus described by Valeton[6] and the apparatus described below has been taken in part from that described by these investigators, but with numerous changes in details of construction.

Essentially the apparatus consists of 2 thermostats (S and C in figures 1 and 2), connected by tubes, with the necessary stirring and circulating devices. The thermostats are filled with saturated solution of the crystals being studied. One thermostat—the "saturator" (S)—contains the crystals, which maintain the solution saturated; the other thermostat—the "crystallizer" (C)—is held at a slightly lower temperature and it is in this cell that growth takes place. The thermostat vessels are storage battery jars, 20 by 20 by 20 cm., with 25 mm. holes drilled through the sides where necessary for the entrance of tubes. The thermoregulators[7] (shown at T and T_1) are filled with mercury, and operate, through relays, the 5-candle-power cylindrical carbon lamps (H and H_1) used as heaters. In the saturator the cooled solution stream flows over a heater

[5] German patent No. 228246, a copy of which I have been unable to secure. A brief description of their apparatus is given in W. Voigt. Lehrbuch der Kristallphysik, p. 9, 1910.

[6] J. J. P. Valeton. Ber. Sachs. Ges. Wiss. 67: 1–59. 1915.

[7] Attention may be here called to the threaded glass parts of the thermoregulators which carry the adjustable contacts. These threaded parts are small homeopathic vials (Whitall Tatum Co.) which have been drawn down and sealed to ordinary soft tubing. I have found their use advantageous in other cases where glass-to-metal connections are necessary.

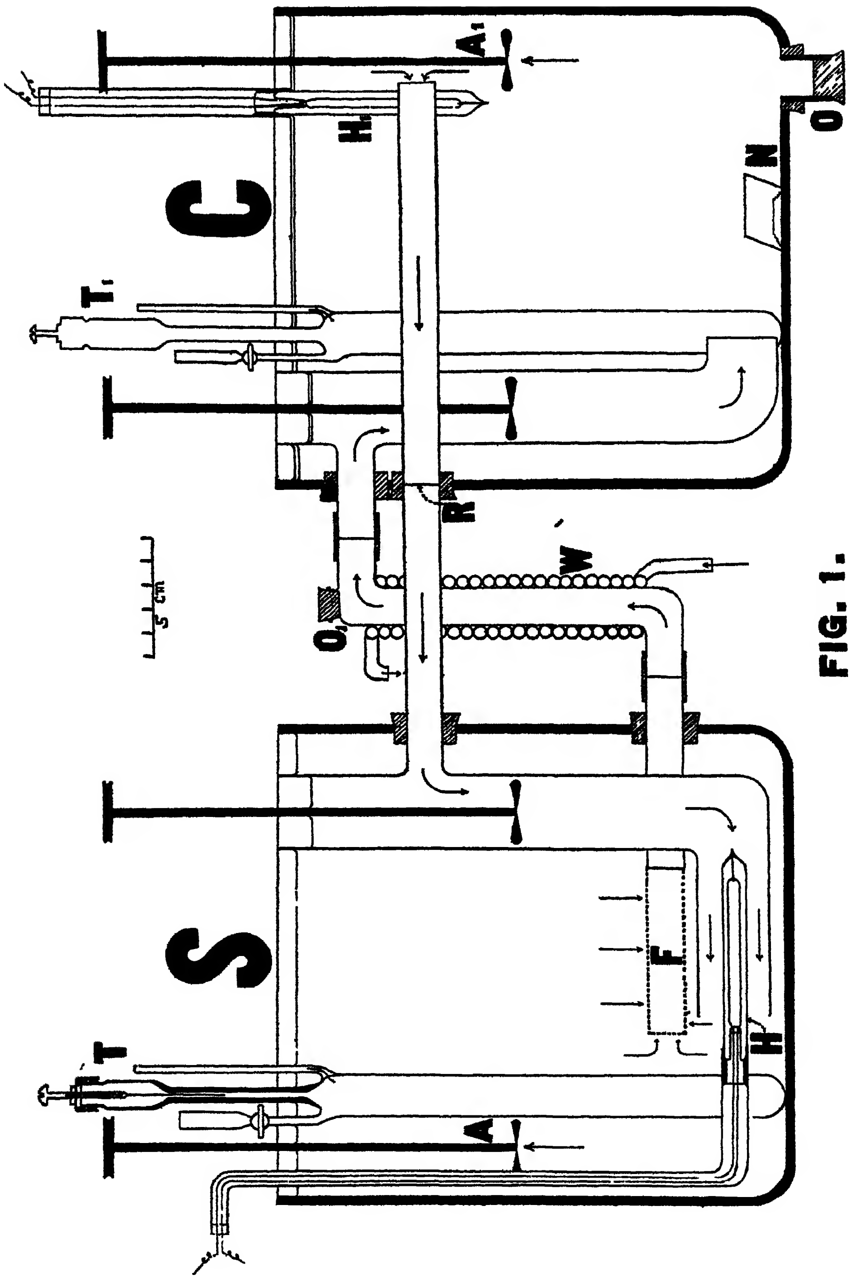

FIG. 1.

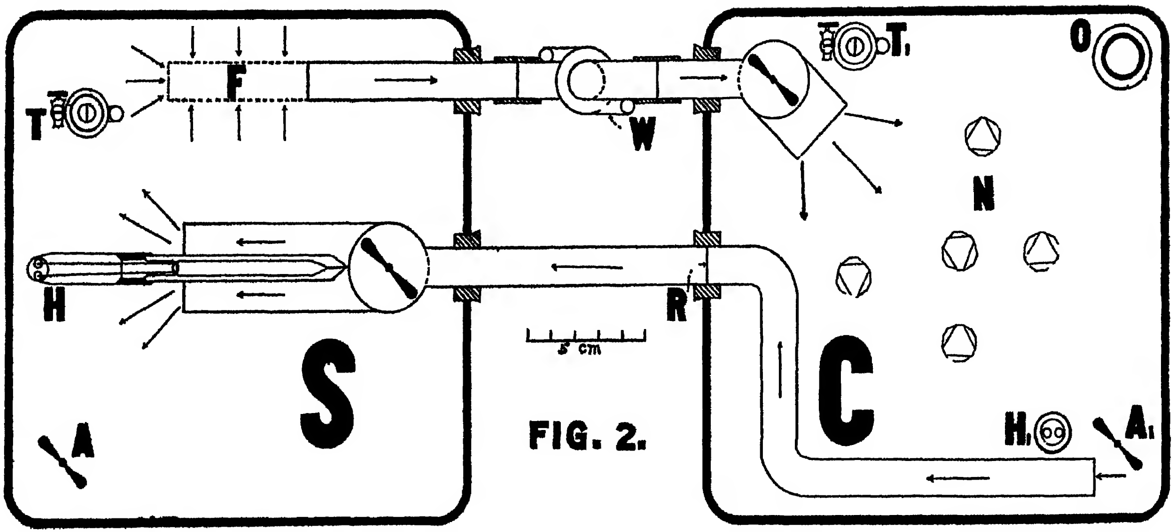

FIG. 2.

Figures 1 and 2. Section and plan of crystal-growing apparatus.

The apparatus consists essentially of two thermostats,—the Saturator (S) and the Crystallizer (C); S is maintained at a temperature slightly higher than C and is about one-third filled with crystals which keep the solution saturated. The saturated liquid is pumped from S into C where the excess material is deposited on small crystals (N), after which the solution is returned to the Saturator; the course of circulation is shown by the arrows.

(H) before striking any crystals. The stirrers are of silver. A coil of small lead pipe (W) serves as a water jacket for one of the tubes connecting the thermostats The openings (O and O_1) permit the removal of volunteer crystals, in case of accident, without disconnecting the entire apparatus; for a similar reason the return tube is cut at (R) and the platinum gauze filter (F) may be detached. The entire apparatus is packed with felt in a large, wooden box.

The degree of supersaturation of the solution entering the crystallizer may be controlled by adjusting (1) the temperature difference between the saturator and the crystallizer, (2) the rate of circulation between the two thermostats, and (3) the temperature and the rate of flow of the cooling water in the coils at (W). The difference in temperature between the saturator and the crystallizer that is permissible depends upon the change of solubility with temperature, and especially upon the extent to which the solution of a particular salt can be supersaturated. In the case of the alums, for instance, solutions containing salt equivalent to 15 per cent supersaturation may be handled without causing precipitation, but on the other hand the change of solubility with temperature is fairly large. Practically, therefore, a temperature difference of 0.3° to 0.5° was found to give good growth.

With other materials, however, this difference might be too large and if so there would result a period of excessive growth, or a shower of volunteer crystals that would ruin the crystals being developed. No measurement of the actual rate of transfer of solution from one thermostat to the other was made The rate of stirring must obviously be kept constant while crystals are being grown. If the room in which the apparatus is placed is subjected to large temperature fluctuations it is necessary to maintain the temperature of the water in the cooling coils at the same temperature as that of the crystallizer.

The course of the circulating solution is as follows: The solution comes into the saturator through tube (R), flows over the heating lamp (H), the hot stream striking the feeding crystals

and becoming saturated. Before the solution returns to the crystallizer it must pass down between more crystals into the platinum gauze filter at (F); thence to the crystallizer. *En route* it is cooled slightly in the water-jacketed tube before entering the crystallizer. The supersaturated current now passes over the nuclei at (N) and excess material deposits thereon. The cooled solution returns through (R) to the saturator. The currents caused by the auxiliary stirring (A and A_1) in the thermostats are such as to assist the main circulation between the two thermostats.

Instead of depending upon chance for the formation of nuclei it is far better to introduce small well-formed crystals which have been developed elsewhere. If a warm saturated solution is allowed to cool overnight there will usually be some small crystals that are suitable as nuclei. Where these crystals have been in contact with the bottom of the vessel there is under each one a small terraced cavity. This has been brought about partly by the fact that mother-liquor did not have access to the bottom surface during growth. While growing in this manner the original nucleus may be lifted several millimeters. When these crystals are placed in the crystallizer they should be oriented with the cavity on top. New growth will soon build up the top to a plane surface. Each day the crystal should be turned over so as to avoid the development of deep hollows underneath. The crystals should likewise rest on plane glass and not on the irregular bottom of the battery jar. Before introducing crystals into the crystallizer it is advisable to dip them into a saturated solution (as in the saturator) and wash off loose particles.

It has been mentioned that the rate of growth is also influenced by the number of nuclei. With a temperature difference of 0.3–0.5° and 5 nuclei present the rate of growth for potash alum was about 1.0 mg. per hour per sq. cm. of crystal surface exposed to the solution.

The surface of the solution in the saturator was uncovered and evaporation allowed to take place—thus helping in the

maintenance of saturation. In the crystallizer, however, the only supersaturation desired is that under control and consequently evaporation was prevented by a layer of kerosene floating on the solution. Crystals introduced into the crystallizer were lowered beneath the oil in a bottle.

It is of great advantage to have large crystals or aggregates of crystals for use in the saturator to serve as "raw material" from which to grow well developed crystals. In the case of the alums, for instance, large-sized material is commercially available, and such is the case with numerous other salts. Where material can not be secured in large particles the finely-divided salt must be used and as this can not be piled up in the saturator like large-sized material, recourse is had to the use of small bags suspended in the solution and refilled from time to time with the fine crystalline material. Under the influence of the oscillating temperature obtaining in the solution in the saturator such finely divided material soon coalesces into aggregates which are entirely suitable for this purpose.

If the presence of fine thread or of wire is not objectionable in the final crystal the nucleus may be suspended in the solution by such means. This avoids the necessity of turning the crystal each day and also gives a more symmetrical crystal. Crystals grown around such suspensions are usable for a great variety of purposes but as pointed out previously such crystals are not suitable for pressure investigations.

Even though the crystals grown under thoroughly controlled conditions appear beautifully clear and perfect to the unaided eye, microscopic examination[8] frequently reveals the presence of minute inclusions, the causes of which require further study. Also, it may be mentioned here that "isotropic" crystals grown under these conditions often show zones of local strain when examined in polarized light.[9]

An observation may be recorded here regarding the development of faces on alum crystals. As normally grown such crystals

[8] Very kindly made by my colleague Dr. H. E. Merwin.

[9] Wright, F. E., and Hostetter, J. C. Journ. Wash. Acad. Sci. 7: 415. 1917.

form flattened octahedra, diagrams of which are shown in position in the sketches of the crystallizer. Ordinarily such crystals are nearly free from any of the related faces such as the cube and the rhombic dodecahedron; the cube face may be observed but it is always small and the rhombic dodecahedral face is even less developed. Such is the case when the crystals are grown continuously without periods of solution intervening. If, for any reason, the growth of the crystal is stopped and solution of the crystal takes place the edges of the crystal are rounded in the initial stages of dissolution: when conditions are changed so that growth recommences the rounded portion of the crystal flattens during growth and in so doing a rhombic dodecahedral face is developed. During the future growth of the crystal this new face is very prominent and in none of the cases observed here has it ever filled out to form the sharp edge of the original octahedron. A similar development of the rhombic dodecahedral face can be induced if the edge of the octahedron is removed by other means and the crystal then allowed to grow. The "repair" of crystals during growth is thus seen to follow along the lines of least resistance.

It should be emphasized here that the mere fact that all essential conditions are under control in the crystal-growing apparatus described above, is not, in itself, a guarantee that any salt can be made to form large crystals under the conditions obtaining therein. Some salts may be readily enough crystallized in large well-formed crystals—other salts under the same conditions will yield a multitude of small crystals rather than a few large ones. Potassium alum and sodium chlorate were grown very successfully in this apparatus but experiments with ammonium chloride yielded only a mass of fine, fernlike crystals instead of growth on certain crystals which had been introduced as nuclei. In this case the effect was not caused by incorrect adjustment of conditions for these fine crystals appeared and increased in size in the crystallizer, thus showing that conditions were optimum. On several occasions all crystals except one were carefully removed from the crystallizing chamber

and circulation of liquid continued, but here again, instead of deposition taking place on the remaining crystal, other nuclei were formed developing later into the usual fernlike growths. These experiments were repeated under a sufficient variety of controlled conditions to show that the phenomenon was connected with certain relations at present beyond our control.

The literature is filled with observations on the effect of foreign material on crystal habit but experience gathered in the course of these investigations has shown that, in general, such effects have been largely overestimated, at any rate in certain classes of salts. Furthermore, it will be shown in future publications that there is nothing mysterious about the action of addition products in many cases, but that a simple explanation based on well-known physico-chemical laws will suffice.

The crystals grown in this apparatus have been used in the study of certain problems connected with the linear force of growing crystals,[10] and also the effects of nonuniform pressure on solubility.[11] The publication of other results, delayed by the war activities of this Laboratory, will be made as opportunity permits.

CRYSTALLOGRAPHY.—*X-ray analysis and the assignment of crystals to symmetry classes.* ALFRED E. H. TUTTON, Past President of the Mineralogical Society of London. (Communicated by R. B. Sosman.)

A memoir on the above subject is contributed by Edgar T. Wherry to a recent issue of this JOURNAL[1] which calls especially for some notice, inasmuch as it is largely based on certain misconceptions regarding fundamental crystallographic facts, of a type which is becoming increasingly common among the growing number of workers and writers on this new and highly inviting subject of X-rays and crystals. The memoir in question assumes that evidence has been accumulating that the crystals of

[10] BECKER, G. F., and DAY, A L. Journ Geol 24: 313–333. 1916.

[11] HOSTETTER, J. C. Journ Wash. Acad. Sci. 7: 79 1917 WRIGHT, F. E, and HOSTETTER, J C. Op. cit 7: 405. 1917.

[1] This JOURNAL 8: 480. 1918. Compare also Dr. WHERRY'S reply, p. 99.

certain substances—notably the diamond, sylvine (potassium chloride), pyrites and its analogues hauerite and cobaltite, the nitrates of barium, strontium, and lead, and the rutile group of minerals—are in a sense intermediate in structure between two crystal classes, possessing some of the attributes of each. It is advocated that the difficulty be overcome in each of such cases by assigning the substance to both classes. It is further assumed that they are usually cases of weak hemihedrism.

The diamond, although formerly classed as hexakis-tetrahedrally hemihedral (class 31), has for some time now, largely owing to the very definite proof of the absence of electric polarity by Van der Veen, been considered as holohedral, that is, as belonging to the class 32 of full cubic symmetry. This view has now been shown to be correct by W. H. and W. L. Bragg, as the result of their X-ray structural analysis. The memoir of Dr. Wherry, however, regards the Bragg result as indecisive, and as indicating holohedrism as a whole, but a tetrahedral structure-unit symmetry. Etch-figures are considered to bring out partial symmetries when equilibrium is delayed, and in the case of diamond they are at first hemihedral, but given longer time become eventually holohedral. It is concluded in the memoir, therefore, that while the system of diamond is cubic, and the space-lattice structure is holohedral, the structure-unit is tetrahedral.

In the case of sylvine, also found holohedral by X-ray analysis, the etch-figures indicate gyrohedral (class 29) symmetry, which it is assumed is due to the difference in atomic volume of potassium and chlorine; whereas in the case of rock-salt, which is undoubtedly holohedral (of class 32), although class 29 etch figures are also produced at first, they are subsequently further developed into class 32 figures and this is supposed to be due to the near equality of the atomic volumes of sodium and chlorine. The memoir finally concludes that this family of halides belongs to the cubic system, with a holohedral space-lattice and a gyrohedral structure-unit.

With regard to the pyrites family of minerals, it is considered that the Bragg results indicate that the space-lattice and crystal molecules of pyrites, FeS_2 and hauerite, MnS_2, in which the two negative atoms are alike, possess pyritohedral (pentagonal dodecahedral) symmetry, and those of cobaltite, CoAsS, in which the two negative atoms are different, "tetartohedral" symmetry. As some specimens of pyrites exhibit tetartohedral traits it is further assumed that the structure of pyrites is Fe = S = S, the two sulphur atoms being of different valency, tetradic and dyadic. The whole group is described as belonging to the cubic system, with a "pyritohedral space-lattice" (*sic*, particularly definitely stated in the table given), and a tetartohedral structure-unit

Barium nitrate and its strontium and lead analogues are similarly assumed, from the X-ray results of Nishikawa and Hudinuki, to have "pyritohedral space-lattices," with a tetartohedral structure-unit in each case.

Rutile, TiO_2, is assumed to be of holohedral habit, but to exhibit occasionally trapezoidal hemihedrism. The somewhat contradictory X-ray results of Vegard and of Williams are discussed, and the views of Williams adopted as more reasonable. The conclusion is that the system is tetragonal, the space-lattice holohedral, and the structure-unit trapezoidal.

The final conclusion in the memoir is that both the symmetry of the space-lattice as a whole, and that of the crystal molecules or unit cells of the space-lattice, may find expression in significant physical features, and that both should be taken into account in the assignment of crystals to symmetry classes, even although it may be necessary at times to state two different classes for the same crystal.

With the first portion of this conclusion all can agree, provided (as is not stipulated in the memoir) that it be kept clear as a fundamental fact, that it is the space-lattice that determines the crystal-system and the obedience to the law of rational indices, while it is the structural detail (represented only by a point in the space-lattice) that determines which particular

one of the 32 classes of possible crystal-symmetry is developed. But with respect to the last sentence of the conclusion—that a crystal can be allocated to two different classes—it is absolutely, fundamentally, wrong and entirely unacceptable. There is no more accurate science than modern crystallography. The old method of regarding crystal-classes as holohedral, hemihedral (half the faces suppressed), and tetartohedral (three-fourths of the possible faces suppressed) is gone forever, and crystal classification is now at length scientifically and very definitely based on the possession of fixed elements (planes and axes) of symmetry, every one of the 32 possible classes of crystals having its own absolutely unique elements of symmetry. A structure either possesses the elements of symmetry of a particular class or it does not; there is no halfway house.

The greatest misconception in the memoir, however, and one which probably gave rise to that just alluded to, is that a space-lattice can be anything but holohedral (*e. g.*, the frequent reference in the memoir to the pyritohedron as a space-lattice). Now there are only fourteen space-lattices, those which Bravais verified and immortalized after their original discovery by Frankenheim, and all are essentially and necessarily holohedral (retaining this term as a convenient one to express full systematic symmetry). They are too simple to be anything else. The three belonging to the cubic system (for all the seven systems are represented among the fourteen) are those having for their elementary cells the cube (No. 1), the centered cube (No. 2) which is a cube with a point at the center, and the face-centered cube (No. 3), a cube with a point in the center of each face. If each point of these lattices be imagined to represent a polyhedron of such a nature that when an unlimited number are packed together in contact, space is completely filled, the No. 1 polyhedron would be a cube, which is obviously a triparallelohedron; that of No. 2 space-lattice would be a cubo-octahedron, an octahedron so far modified by faces of the cube that each octahedral face has the shape of a regular hexagon, the solid being a heptaparallelohedron; and that of No. 3 would be a

dodecahedron, a hexaparallelohedron. The point-systems corresponding to the crystal-classes of lower than the full systematic symmetry are not space-lattices at all, but Sohncke regular point-systems, including in many cases those involving enantiomorphism added by Schönflies, Fedorov, and Barlow, and later also accepted by Sohncke. The pyritohedron, the "hemihedral" pentagonal dodecahedron, referred to in the memoir and its accompanying table as a space-lattice, is not a space-lattice, but a Sohncke regular point-system; indeed Sohncke allocates three of his point-systems, Nos. 54, 55, and 56 to the pyrites class 30. As the space-lattice is always holohedral, the suggestion made in the memoir, if carried out, would result in every substance belonging to a class other (lower) than the holohedral class of the system to which it conforms being relegated not only to that subsidiary ("hemihedral" or "tetartohedral") class in question, but also to the holohedral class of the system, that is, to two different classes of the same system, possessing quite different elements of symmetry, which is absurd. For all structures, even "tetartohedral" ones, have a fundamental space-lattice, about the nodes of which their detailed atomic structure may be considered as grouped. Indeed, the point-systems may quite legitimately be, and often are, considered as composed of interpenetrating space-lattices.

It cannot, therefore, be made too clear that the space-lattice only determines the crystal system and not the class. It expresses the grosser crystal structure, that of the molecules or polymolecular groups, each point or node of the lattice representing a single molecule or the small group of two, three, four, etc., molecules necessary to the complete crystal structure. It is the whole structure, including the detailed arrangement of the atoms in the molecule or group, which determines the class. Pyrites most certainly belongs to the dyakis dodecahedral class 30, of which the pentagonal dodecahedron is a prominent form, the third of the five cubic classes, but its space-lattice is No. 3, the centered-face cube, just as in the case of the alkali chlorides. Hauerite is similar, but there is some evidence from the Braggs'

results that cobaltite may belong to the tetrahedral pentagonal dodecahedral class 28, like barium nitrate. The Braggs have shown that the alkali chlorides are most probably holohedral. The rutile group requires much more research, there being no satisfaction in building conclusions on contradictory data.

The present moment is a dangerous one in the history of the use of X-rays in unravelling crystal structure. No more speculations built on incorrect crystallography are desirable. What is needed is solid, well and carefully carried out, prolonged and thoroughly tested experimental work, and a complete revision of the principles on which results are based, with the view of rendering them both more fully trustworthy and of definite application. Two fundamental problems are especially urgently requiring solution before much further progress can be made, namely, the falling away of reflection intensity with increase of order of spectrum, and the quantitative relationship between reflection-intensity and atomic number or atomic weight (mass). While we cannot hope to get much more information from the Laue radiograms than at present, the Bragg spectrometric method is full of promise, and when these root-problems are satisfactorily settled much more progress may be expected to be made with the finer details of the structure of the more important crystalline substances.

YELVERTON, S. DEVON, ENGLAND.
NOVEMBER 18, 1918.

CRYSTALLOGRAPHY.—*Reply to Dr. Tutton's discussion of the assignment of crystals to symmetry classes.* EDGAR T. WHERRY, Bureau of Chemistry.

In the course of his scientific study of natural phenomena, man is continually devising pigeon-holes into which to distribute given series of facts. Nature, however, often refuses to be pigeon-holed, and persists in bringing to the attention of all who will stop, look, and listen numerous facts which do not accord with the classification in vogue at a particular time. New classifications must therefore be continually worked out

as science advances; and this may be just as true in crystallography as in any other field. In the paper under discussion[1] the writer endeavored to point out an instance where changes in view-point appear to be needed, and is glad to take up Dr. Tutton's criticism (preceding article) and to show that the difference between us consists chiefly in our willingness to admit the above proposition. Dr. Tutton's summary of the paper in question is reasonably adequate; but whether that paper is based on "misconceptions regarding fundamental facts" must be decided by the reader of the present discussion.

The magnificent research on diamond by Fersmann and Goldschmidt[2] has surely established for all time the fact that tetrahedral (Class 31) features are often shown by both the habit and the etch figures of this mineral. The proof of the absence of electric polarity by Van der Veen, which no attempt has been made to discredit, can not alter that fact. What is needed is an explanation of the apparent discrepancy, and that is what the writer endeavored to supply. The structure of the mineral having been established to the satisfaction of all concerned by the Braggs, the writer saw therein a way to account for the difficulty, for the structure as a whole, with which the electric polarity is presumably connected, is admittedly holohedral (Class 32) while the symmetry of the unit cells is tetrahedral (Class 31), which is reflected in the habit and etch-figures. In other words, the writer accepts the correctness of the work of all the authors, whereas those by whom diamond "has for some time now ... been considered as holohedral" must ignore or discredit the work of Fersmann and Goldschmidt, as well as overlook the significance of the Bragg demonstration that the symmetry of the unit cell of diamond is less than that of the structure as a whole. The last sentence of the writer's conclusion, which Dr. Tutton considers "absolutely, fundamentally

[1] This JOURNAL 8: 480. 1918.

[2] Through the writer's failure to correct proof of his paper the title of the work by these authors was given as "Diament" instead of "Diamant." Also, the heading of the last double column of the table should, of course, read "atomic."

wrong and entirely unacceptable" is, as the writer endeavored to show, a direct corollary to the Braggs' work. And since Dr. Tutton elsewhere in his discussion accepts the results of the Braggs, it seems evident that he does not appreciate the writer's viewpoint at all.

The writer made no attempt to revive the "old method of regarding crystal classes as holohedral, hemihedral, and tetartohedral," but merely used such terms, following Dana, as convenient, brief designations of certain symmetry classes. None of his conclusions would be altered were the classes to be referred to by numbers or by any other method. Nor has he denied that "every one of the 32 possible classes has its own absolutely unique elements of symmetry" or that "a structure [as a whole] either possesses the elements of symmetry of a particular class or it does not."

It certainly seems inconsistent in Dr. Tutton to assert that "there are only fourteen space-lattices," in the same paper in which he accepts the correctness of the Braggs' work on diamond. For the structure they assign to that mineral, though not included among Bravais's fourteen, is, *according to the criterion used by Dr. Tutton in his discussion*, a space-lattice. Each point of this structure may be "imagined to represent a polyhedron of such a nature that when an unlimited number are packed together in contact, space is completely filled." In this case the polyhedron is a regular tetrahedron, so far modified by faces of the rhombic dodecahedron that each tetrahedral face has the shape of a regular hexagon.[3] X-ray studies have shown, moreover, similar lattices to exist, as for instance a trigonal one in bismuth. How many others may be discovered by subsequent research the writer would not venture to predict, but he certainly would not claim that our present knowledge is complete and final in this (or any other) respect.

As far as pyrite is concerned, the underlying structure is admittedly not a simple space-lattice, but compound, or com-

[3] Compare ADAMS. *Note on the fundamental polyhedron of the diamond lattice.* This JOURNAL 8: 240. 1918.

posed of two interpenetrating simple ones. The disagreement over this point, therefore, is merely a matter of definition of terms, Dr. Tutton preferring to use "interpenetrating point-system" for what the writer would call a "compound space-lattice." Substitution of the one term for the other would not alter the conclusions reached in the original paper to the slightest degree. It should be noted, further, that the view that molecules rather than atoms occupy the points or nodes of space-lattices has been rather definitely disproved by the very X-ray study of crystals which started the present discussion.

To summarize: in the paper under discussion, the writer assembled the data for a number of crystals, in the assignment of which to symmetry classes one method of study gives results which conflict with those of other methods of study. He presented an interpretation of the relations which appeared to him capable of reconciling these discordant results, involving the new conception that crystals may belong to one symmetry class with respect to some properties and to another class with respect to other properties. Dr. Tutton apparently feels that the present views of crystallography are adequate to explain all past (and future) crystallographic observations. Rather than recognize that diamond, pyrite, etc., belong simultaneously to two different classes, depending on what property is considered, he prefers to ignore observations which do not accord with the one of these symmetry classes which for one reason or another he wishes to accept for each substance. In diamond, he overlooks the Class 31 habit and etch-figures, in pyrite the Class 28 habit and electrical phenomena, and so on. The writer does not believe that ignoring results which do not suit a preconceived theory is the proper scientific spirit, and prefers to modify or revise current ideas when necessary to explain undeniable observational facts, even though this may lead to his being accused of putting forward "speculations built on incorrect crystallography."

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors The abstracts should conform in length and general style to those appearing in this issue.

PHYSICS.—*The conditions of calorimetric precision.* WALTER P. WHITE. Journ. Amer. Chem. Soc. **40**: 1872–1887. December, 1918.

In a calibrated calorimeter practically all the errors come in temperature measurement, and the most, though often not the greatest of these come in the "cooling correction," that is, the determination of the effect of the thermal leakage between calorimeter and environment. This thermal leakage is analyzed into its factors. R. B. S.

INORGANIC CHEMISTRY.—*The place of manganese in the periodic system.* F. RUSSELL V. BICHOWSKY. Journ. Amer. Chem. Soc. 40: 1040–1046. July, 1918.

The older arguments placing manganese in the seventh group of the periodic system (*i. e.*, giving manganese a normal valence of 7) now appear open to question. On the other hand there are 12 different lines of argument based on purely chemical relationships which indicate its position in the eighth group. This conclusion is also in accord with the more decisive reasoning based on atom color presented in a previous paper. An improved form of the periodic table, showing the relations of the eighth and rare earth groups to the rest of the periodic system, is presented. F. R. B.

INORGANIC CHEMISTRY.—*The melting points of cristobalite and tridymite.* J. B. FERGUSON and H. E. MERWIN. Amer. Journ. Sci. 46: 417–426. August, 1918.

The melting point of cristobalite has been redetermined and found to be 1710 ± 10° C. This value is consistent with the experimental evidence which was obtained in a study of a portion of the ternary

system $CaO-MgO-SiO_2$ and which had caused the earlier investigations to be viewed with suspicion. Tridymite is unstable at its melting point and this unstable melting occurs at $1670 \pm 10°$. Artificial tridymite made from quartz could not be melted owing to the rapidity of the tridymite-cristobalite inversion, but a sharp melting was obtained with natural material. Since this unstable melting point is below that of cristobalite, there can no longer be room to doubt that cristobalite is the high temperature form of silica. R. B. SOSMAN.

GEOLOGY.—*Asphalt deposits and oil conditions in southwestern Arkansas.* HUGH D. MISER and A. H. PURDUE. U. S. Geol. Survey Bull. 691-J. Pp. 271–292, with maps. 1918.

There are seven asphalt deposits in Pike and Sevier counties, Arkansas. The asphalt occurs in the Trinity formation of Lowe, Cretaceous age which rests on upturned edges of Carboniferous limestone and sandstone. Doubtless the asphalt is a residue of crude petroleum whose lighter and more volatile parts have escaped by evaporation. This petroleum is believed to have been derived from the Carboniferous rocks underlying the Trinity formation, near the base of which the asphalt is found. The geologic structure is not favorable to accumulation of petroleum, and the few wells that have been sunk for oil have not found it in commercial quantity. R. W. STONE.

GEOLOGY.—*Italian leucitic lavas as a source of potash.* HENRY S. WASHINGTON. Met. and Chem. Eng. **18**: 65–71. January 15, 1918.

This paper attempts an evaluation of the total amount of potash that is present in the lavas of the six chief Italian volcanoes along the west coast that have erupted leucitic lavas, which are therefore high in potash.

It is considered that in these volcanoes Italy possesses one of the largest if not the largest of the visible supplies of potash known to exist. Some other silicate rock sources of potash are briefly discussed, especially the Leucite Hills in Wyoming and the belt of glauconite that extends from New Jersey into Virginia. R. B. S.

MINERALOGY.—*Augite from Stromboli.* S. KOZU and H. S. WASHINGTON. Amer. Journ. Sci. **45**: 463–469. June, 1918.

This paper records the optical characters and chemical composition of the augite crystals that were being thrown out of the volcano of

Stromboli during the visit of A. L. Day and the authors in August 1914. Analyses of the lavas are also given. The augite is shown to be of a commonly occurring type. The paper is part of an investigation on the augites and other pyroxenes of Italian and other localities.

H. S. W.

VOLCANOLOGY.—*The representation of a volcano on an Italian renaissance medal.* H. S. WASHINGTON. Art and Archaeology 7: 256–263. July–August, 1918.

This paper describes a lead medal of Leonello Pio, Count of Carpi, which dates from the beginning of the sixteenth century. The reverse represents a volcano in violent eruption, and it is shown that this commemorates almost certainly an eruption of Vesuvius in 1500, concerning the actuality of which there has existed considerable doubt. If so, this is the earliest known representation of Vesuvius in eruption.

H. S. W.

ENTOMOLOGY.—*Comparative morphology of the order Strepsipteras together with records and descriptions of insects.* W. DWIGHT PIERCE. Proc. U. S. Nat. Mus. **54**: 391–501, pls. 64–78. 1918.

This article comprises the second supplement to a monographic revision of the order *Strepsiptera* published as Bulletin 66 of the United States National Museum. It contains additional biological studies on the occurrence of parasitism by these insects, and a review of all literature on the order which has been published since the first supplement. The leading feature of the article is the study of the comparative morphology of the order, tracing the modification of the various portions of the thoracic structures especially throughout the group. It is shown that the prescutum of the metathorax from being a transverse separate piece moves backward into the scutal area in the form of a triangular piece, and in successive modification tends to supply the scutum and approach, and even push backward the scutellum. It is shown that the changes in the thoracic structure can be coordinated with the antennal and wing structures which have previously been used for separating the families and genera. A more complete argument as to the reasons for separating the group as an order is presented together with a set of five rules for the formation of an insect order. A number of new species and genera are described and illustrated, and

the article also contains a large list of new host records and a bibliography of recent works. W. P. D.

ENTOMOLOGY.—*Medical entomology a vital factor in the prosecution of the War.* W. DWIGHT PIERCE. Proc. Ent. Soc. Wash. **20**: No. 5. Pp. 91–104. October 3, 1918.

The author brings out in this article the importance of entomological work in the study of diseases showing that the entomologist, parasitologist, and physician are all needed to work out their particular phases of the problems of disease transmission. Seven types of relationships of insects, disease organisms, and vertebrate hosts are defined. Various types of transmission of disease organisms by insects are also illustrated. The author brings out especially the importance of insect-transmitted diseases to armies and finally mentions a number of problems which still remain to be solved. W. D. P.

ANTHROPOLOGY.—*Kutenai tales.* FRANZ BOAS, together with texts collected by ALEXANDER FRANCIS CHAMBERLAIN. Bur. Amer. Ethnol. Bull. 59. Pp. 387

This comprises 77 texts in the Kutenai Indian language with English translations, 25 with both interlinear and free translations. Forty-four were collected in 1891 by the late Prof. Alexander F. Chamberlain of Clark University, the remainder by Professor Boas in 1914. They are followed by 32 pages of Abstracts and Comparative Notes and Kutenai-English and English-Kutenai vocabularies. Kutenai constitutes one of the smaller linguistic stocks, Kitunahan, and embraces but two closely related dialects. The material is therefore of unusual value to the student of American languages, while the comparative notes render it equally important to the folklorist and those interested in comparative mythology. J. R. SWANTON.

APPARATUS.—*Calorimetric methods and devices.* WALTER P. WHITE. Journ. Amer. Chem. Soc. **40**: 1887–1900. December, 1918.

In this paper various forms of jacket covers (and of stirrer mountings) are described and compared. R. B. S.

APPARATUS.—*Some points regarding calorimeter efficiency.* WALTER P. WHITE. Journ. Franklin Inst. **186**: 279–287. September, 1918.

This discussion has special reference to the precision required and the conditions prevalent in commercial work. R. B. S.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The Board of Managers met on January 27, 1919. A budget for the year was adopted, renewing the appropriations for 1918 with minor changes. A revision of the Standing Rules of the Board, as recommended by the Executive Committee, was adopted. The following appointments were announced: Members of Executive Committee, PAUL BARTSCH and WALTER T. SWINGLE; Committee on Membership: T. WAYLAND VAUGHAN, chairman, G. N. COLLINS, WALTER HOUGH, H. E. MERWIN, and E. T. WHERRY; Committee on Meetings: E. W. SHAW, chairman, C. W. KANOLT, H. H. KIMBALL, H. L. SHANTZ, and S. S. VOORHEES; Editor of Journal for term 1919–1921, ROBERT B. SOSMAN.

The following persons have become members of the ACADEMY since the last issue of the JOURNAL:

Mr. EDWARD CHESTER BARNARD, International (Canadian) Boundary Commissions, 719 Fifteenth Street, Washington, D. C.

Dr. SAMUEL JACKSON BARNETT, Department of Research in Terrestrial Magnetism, Carnegie Institution of Washington, Washington, D. C.

ROBERT B. SOSMAN, *Corresponding Secretary.*

GEOLOGICAL SOCIETY OF WASHINGTON

The 327th meeting of the Society was held in the lecture room of the Cosmos Club on April 10, 1918. The regular program was as follows:

EDWIN KIRK: *Paleozoic glaciation in southeastern Alaska.* During the past field-season a tillite of Silurian age was found in southeastern Alaska. Kosciusko and Heceta Islands, where the best Silurian glacial deposits are to be found, lie between 55° and 60° north latitude and 133° and 134° west longitude. These islands are situated on the west coast of Prince of Wales Island, toward the northern end. The most favorable locality for an examination of the conglomerate is in the large bay about midway on the north shore of Heceta Island. The coast here is well protected from storms and there is a continuous outcrop of the limestone underlying the conglomerate, the conglomerate itself, and the overlying limestone. In places the conglomerate is well broken down by weathering, making the collection of pebbles and boulders an easy matter. As exposed, the beds outcrop along the shore between tide levels, and give an outcrop perhaps 2,000 to 3,000 feet in length.

The glacial conglomerate is under- and overlain by fossiliferous marine limestones. The succession of beds is clearly shown and unmistakable. The strata as a whole in this region are badly disturbed, and as is the case throughout southeastern Alaska, contacts are very poorly shown, being, as a rule, indicated by an indentation of the shoreline and a depression running back into the timber. At present, therefore, although the relative positions of stratigraphic units are obvious, the character of the unconformity and the nature of the passage beds are poorly known.

The limestone series overlying the conglomerate carries a rich *Conchidium* fauna. In certain thin beds the rock is almost wholly made up of the brachiopods. This fauna appears to be identical with that of the Meade Point limestone of the Wrights and Kindle. The type exposure of the latter is at the northern end of Kuiu Island. At the base of the limestone at this locality is a boulder bed which I believe to be glacial in origin and to be correlated with the conglomerate of Heceta. The limestones below the conglomerate likewise carry a rich fauna consisting of pentameroids, corals, and gasteropods. The general aspect of both faunas seems to place them as approximately late Niagaran in age.

The conglomerate itself has a thickness of between 1,000 and 1,500 feet. In the main the conglomerate appears to consist of heterogeneous, unstratified, or poorly stratified material. Rarely lenticular bands of cross-bedded sandstone occur in the mass. These are clearly water laid and indicate current action.

The boulders in the tillite range in size up to two or three feet in length, as seen. The boulders consist of greenstone, graywacke, limestone, and various types of igneous rocks. Limestone boulders are scarce. All the boulders are smoothed and rounded. Facetted boulders are numerous and, given the proper type of rock, characteristic glacial scratches are to be found. The scratches show best on the fine-grained, dense greenstone. Limestone boulders and certain types of igneous rocks do not show them at all. The shoreline is strewn with these pebbles and boulders, which were undoubtedly derived from the conglomerate, as they are not to be found on the adjacent limestone shores. All the material collected was taken from the conglomerate itself, however. This is well broken down by weathering in some places, and the pebbles may be picked out with the fingers or tapped out with the hammer.

Throughout the Paleozoic section of southeastern Alaska are vast thicknesses of volcanic material, tuffs, breccias, and flows. Considering the sediments as a whole, climatic conditions through the Paleozoic do not seem to have been very different from those of comparatively recent times and physical conditions may have been very nearly the same.

H. E. Merwin and E. Posnjak: *The iron-hydroxide minerals.* Studies of composition, density, optical properties, and thermal be-

havior have led to the conclusion that only one compound of ferric oxide and water is known, $Fe_2O_3.H_2O$, which exists in two pure crystalline forms, goethite and lepidocrocite. The fibrous material commonly known as limonite is really fibrous goethite with additional water, silica, etc., held in capillaries. It has been possible to find a series of specimens representing the expectable properties of such impure fibrous goethite with variable water content. Turgite appears to be mix-crystals of $Fe_2O_3.H_2O$ and hematite, with properties varying according to the composition.

The amorphous brown iron ores when air dried contain sub-microscopic pores from which water has escaped, but they still hold in these pores variable amounts of water in excess of the formula $Fe_2O_3.H_2O$. They often show marked double refraction due to strain, but are readily distinguished from fibrous goethite by lack of splintery fracture and by lower refractive index.

All these minerals except well-crystallized goethite often occur in very close association.

J. B. MERTIE, JR.: *Repeated stream piracy in the Tolovana and Hess River Basins, Alaska.* The theme of particular interest to which this paper was devoted is an example of stream piracy effected by one stream at the expense of another, and a subsequent repetition of the same process under different physiographic conditions whereby the second stream recovered a considerable proportion of its former drainage. The present watershed therefore represents the third recognizable period of stability in the physiographic history of the two drainage basins.

The two streams in question are Livengood Creek, a tributary of Tolovana River, and the south fork of Hess River, in the Tolovana district, northwest of Fairbanks, Alaska. Gold-placer mining on Livengood Creek has furnished the necessary underground data on the configuration of bedrock under the gravels. An abnormally steep bedrock gradient at the lower end of the old bench channel on Livengood Creek justifies the inference that this stream in its earliest recognizable stage was much shorter than at present. The pronounced back-hand drainage of its present upper tributaries is regarded as corroboratory evidence of this hypothesis. Also the present divide between the two streams has been found by drilling to be silt-filled. An original stream piracy is thus deduced, whereby Livengood Creek stole the headwater tributaries of the south fork of Hess River. The depth to bedrock in the present silt-filled divide, and the depth to bedrock in a narrow gorge in the lower part of the south fork of Hess River, together with the elevations at these two localities, show exactly how much of the upper drainage of the south fork of Hess River was pirated.

The new physiographic condition that brought about the original piracy was a progressive drowning or inundation of the stream valleys

of the Yukon-Tanana region, which resulted in a regional elevation of the base level, and was accompanied by extensive silt alluviation. This new physiographic cycle took place in at least two stages, at the end of the first of which occurred a period of stability when the piracy of the south fork of Hess River by Livengood Creek was accomplished. Subsequently, these silt-filled valleys were drained, and the regional base level was reduced, and it was during this period that the final readjustment of the two drainage basins was effected, and the south fork of Hess River recovered a large part of its former drainage. Superposition of both streams onto bedrock has been responsible for the preservation of the present silt-filled watershed between them.

This topic is discussed in more detail in U. S. Geological Survey Bulletin 662-D, entitled "The Gold Placers of the Tolovana District, Alaska."

The 328th meeting of the Society was held in the Conference Room of the Director of the U. S. Geological Survey on May 8, 1918. The regular program was:

GEORGE OTIS SMITH: *A century of government geological surveys.* Published in A Century of Science in America. Yale University Press, 1918. Also in American Journal of Science Vol. 46, pp. 171–192, 1918.

At the 329th meeting of the Society, held on December 11, 1918, the Presidential address was delivered by the retiring President, FRANK H. KNOWLTON: *Evolution of Geologic climate.* The address will be published in full in the Bulletin of the Geological Society of America at a later date.

At the Twenty-Sixth Annual Meeting held on the same evening the following officers were elected for the ensuing year: *President,* E. O. ULRICH; *Vice-Presidents,* G. H. ASHLEY and H. S. GALE; *Treasurer,* WM. B. HEROY; *Secretaries,* R. W. STONE and R. S. BASSLER; *Members at-Large-of-the-Council,* L. W. STEPHENSON, H. G. FERGUSON, D. F. HEWETT, R. C. WELLS, EUGENE STEBINGER.

ESPER S. LARSEN, JR., *Secretary.*

WASHINGTON SOCIETY OF ENGINEERS

Ten meetings of the Society were held during the year 1918 as follows:

January 15, 1918: WILLIAM C. EDES, Chairman of the Alaskan Engineering Commission: *The Alaska Railroad.*

February 5, 1918: Joint meeting with the Washington Section of the American Institute of Electrical Engineers. Professor C. A. ADAMS, of Harvard University: *Standardization in engineering.*

February 19, 1918: Lieut. Col. HENRY S. GRAVES, Forester and Chief of the U. S. Forest Service: *The Forest Engineers in France.*

March 4, 1918: WILLIAM B. LANDRETH, Deputy State Engineer of New York: *Relation of the Barge Canal to the transportation problems of the United States.*

March 19, 1918: J. O. MARTIN, of the Chesapeake and Potomac Telephone Company: *Wires of war.*

April 1, 1918: Moving pictures of the Battle of Cambrai.

April 16, 1918: Hon. C. B. MILLER, Member of Congress from Minnesota: *Personal experiences on the Western Front.*

The regular meeting scheduled for October 8, 1918, was not held. This was in conformity with the wishes of the Board of Health, on account of the epidemic of influenza.

November 19, 1918: Moving pictures: *From ore to finished "National" pipe.*

December 3, 1918: Annual banquet. Speakers: EDWIN F. WENDT, President of the Society; ADOLPH C. MILLER, Member of the Federal Reserve Board; CHARLES PIEZ, Vice-President and General Manager of the Emergency Fleet Corporation; IRA W. MCCONNELL, of the American International Shipbuilding Corporation; Prof. O. M. W. SPRAGUE, of the Council of National Defense; and Dr. H. W. WILEY.

December 17, 1918: Annual Meeting for the election of officers; moving pictures illustrating the highways of the United States. The following officers were elected for the year 1919: *President,* MORRIS HACKER; *Vice-President,* WILLIAM C. THOM; *Secretary,* H. C. GRAVES, *Treasurer,* G. P. SPRINGER; *Members of the Board of Direction, 1919–1920,* JOHN C. HOYT, ANTHONY F. LUCAS, OSCAR C. MERRILL, EDWIN F. WENDT.

H. C. GRAVES, *Secretary.*

SCIENTIFIC NOTES AND NEWS

Dr. P. W. Bridgman has returned from the naval experimental station at New London, Connecticut, to the Jefferson Physical Laboratory, Harvard University, Cambridge, Massachusetts.

Dr. Edgar Buckingham, who has been associated with the work of the scientific attaché of the American Embassy in Rome, returned to Washington in February.

Dr. George H. A. Clowes, formerly of the Gratwick Research Laboratory at Buffalo, N. Y., and lately engaged in research at the American University Experiment Station of the Chemical Warfare Service on the physiological effects of war gases, left Washington in January to take up biochemical research at the laboratories of Eli Lilly & Company, of Indianapolis, Indiana.

Dr. Oliver L. Fassig, of the U. S. Weather Bureau, has been elected secretary, and Mr. Francois E. Matthes, of the U. S. Geological Survey, treasurer, of the Association of American Geographers.

Major General John Headlam, who lectured before the Academy in April 1918, on "The development of artillery during the war," has been awarded the distinguished service medal by Secretary of War Baker, "for exceptionally meritorious and distinguished services rendered the United States Army while serving as chief of the British Artillery Mission to the United States."

Dr. Ales Hrdlicka, Curator of Physical Anthropology in the United States National Museum, has been made an Honorary Fellow of the Royal Anthropological Institute of Great Britain and Ireland.

Dr. M. S. Sherrill, formerly with the Ordnance Department in Washington, sailed in January for an extended trip in South America.

Dr. F. H. Symth, formerly of the Massachusetts Institute of Technology, and lately captain in the Chemical Warfare Service, stationed at the American University Experiment Station, has received a temporary appointment as physical chemist at the Geophysical Laboratory, Carnegie Institution of Washington.

Vilhjalmur Stefansson was awarded the Hubbard Gold Medal of the National Geographic Society on January 10, 1919.

Word has been received that Mr. M. N. Straughn, formerly of the Bureau of Chemistry in Washington, and a member of the Chemical Society, died in Porto Rico on January 9, 1919.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 9 MARCH 4, 1919 No. 5

PETROLOGY.—*Microscopic examination of clays.* R. E. SOMERS, Cornell University. (Communicated by David White.)

Most of the clays referred to in this report were examined microscopically in order to determine the minerals contained in them, and in addition thin sections of some of the burned samples were studied so far as time would permit in order to obtain some idea of the changes that took place in burning.

The investigation is not to be regarded as an exhaustive one, as much still remains to be done along this line, but so far as it went, it is thought that the results are of interest.

Table 1 gives the minerals that were noted in the different specimens examined, and also their approximate abundance.

IDENTIFICATION AND CHARACTER OF MINERALS

Quartz.—When in medium or coarse grains, quartz can be readily discriminated by means of its index of refraction, low interference color, and lack of cleavage. There are no other minerals in clays which resemble it under these conditions. When, however, it is in small grains, it greatly resembles kaolinite. Its index of refraction is then of little assistance, the interference color is lowered to about that of the kaolinite, and its determination has to depend upon its more angular shape and its more rapid extinction, or "quicker wink." Such grains are generally too small to make use of the difference in optical character.

While quartz was noted in many of the clays examined, it was particularly abundant in the residual ones. Most of the Wilcox clays from the Embayment area showed but little.

Kaolinite.—This can be distinguished by its orthodox charac-

TABLE I

THE COMPOSITION OF CLAYS

Formation and locality[a]	Quartz	Hydromica	Kaolinite	Rutile	Zircon	Tourmaline	Epidote	Titanite	Diaspore	Halloysite	Colloid matter
RESIDUAL CLAYS											
From Granite											
English china clay, washed	S[b]	M	VA								
From Cambrian sandstone (Chikies)											
Frazer, Pa.	A	M	A	C							
From Cambrian schist											
Mt. Holly Springs, Pa., Sandusky Port. Cem. Co.	C	C	A	C							
Mt. Holly Springs, Pa.	C	A	VA	C		S					
Mt. Holly Springs, Pa., Phil. Clay Co.	A	A	A	C		S					
Mt. Holly Springs, Pa., washed, Phil Clay Co.	C	C	A	S		S					
Mt. Holly Springs, Pa., Holly Clay Corp'n	C	C	A	S	S	S					
Mt. Holly Springs, Pa., washed, Holly Clay Corp'n	M	C	VA	C			S				
Beavertown, Pa.	C	S	VA		S						
Narvon, Pa., Whittaker pit	S	A	A	S	S	C					
Narvon, Pa., Diller pit	A	A	A	C	S	S	S	S			
From Cambrian (Chikis quartzite)											
Honey Brook, Pa.	VA	C	S	C		S					
From Cambrian (Gatesburg) clayey sandstone											
Scotia Centre, Pa.	S	A?	C?	S	S	S					
Warriors Mark, Pa.	A	S	VA	A		S		C?			
Furnace Road, Pa., Colonial Clay Co.	A	S	A	C	S						
From Cambrian shale											
Cold Spring, Va.		S	A	A	S	S					
From Cambrian limestone											
Lutesville, Mo.	A	A	A								
Lutesville, Mo., No. 1 clay	C	A	A	S			S				
Lutesville, Mo., No. 2 clay	C	C	A	A		S	S				

[a] The minerals listed here represent the identifiable grains, but some of them contain a variable quantity of exceedingly small grains not identifiable, and which are indicated in the column headed Colloid matter. Aside from this, most of the clays undoubtedly contain colloidal particles so small as not to be visible with the ordinary microscope.

[b] S, scarce; C, common; M, moderate amounts; A, abundant; V A, very abundant.

From Oriskany shales, limestones and sandstones											
Kunkletown, Pa., disintegrated quartzite	A		S	S							
Kunkletown, Pa., clay with quartzite	C	C	A	A		S					
Kunkletown, Pa., clay with quartzite, washed	C	C	A	C							
Saylorsburg, Pa., Crude No. 1	A	A	A	A		S		S			
Saylorsburg, Pa., Crude No. 2	C	A	A	A			S				
Saylorsburg, Pa. washed	C	A	A	S							
Saylorsburg, Pa., Crude, Cement Company's mine	C	C	A	A	S	S					
Shirleysburg, Pa.	S	C	A	A	S						
MISCELLANEOUS RESIDUAL CLAYS											
Bauxite, Ark., banded clay under bauxite		S	VA	A			S	S			
Bauxite, Ark., white clay under bauxite		S	VA	S	S						
(Both have some large flakes of mica)											
Oreana, Nev., Pitt-Rowland deposit	A	A[c]	A	S			S				
Lovelocks, Nev., Adamson-Dickson deposit	A		A	S							
Beatty, Nev., Bond-Marks deposit			S	S						VA	
Antioch, Calif.	S	S	VA	S		S					M?
Fort Payne, Ala., Brower Mine	C	A	A	A		S					
Fort Payne, Ala., Cochrane pit. Siliceous bauxite	S	C		A	S	S					A
Fort Payne, Ala., Cochrane pit, bauxite		S	M	A	S						VA
Bynum, Ala., Kraus pit, white clay		A	A	S		S					
Bynum, Ala., Kraus pit, black clay		C		C	S						A
SEDIMENTARY CLAYS											
Carboniferous											
Cheltenham Clay, St. Louis dis., Mo.											
Raw washed pot clay, LaClede-Christy	C	A	A	S							
Weathered pot clay, LaClede-Christy	C	A	C	A	S	S					
Fire-brick clay, LaClede-Christy	C	A	S	S				S			
Selected crude clay, LaClede-Christy	C	A	S	S							
Weathered pot clay, Highland Clay Co.	S	A	A	S	S						
Washed pot clay, Highland Clay Co.	C	A	C	A			S				
Indianaite, Huron district, Indiana											
Earthy white clay		A	A	S						C	
Massive white clay		S	C	C						A	
Flint Clay district, Central Missouri											
Plastic clay, Bland, Mo.	A	C	S								
White clay, Owensville, Mo., Sassman pit		S	S	S							C
Red clay, Owensville, Mo., Sassman pit			S	C							C

[c] Probably mostly sericite.

Flint clay, Owensville, Mo., Sassman pit			S	C							C
Flint clay, Hofflins, Mo., Cox pit		S		S	S	S					C
Flint clay, Hofflins, Mo., Cox pit		S	VA	A	S	S			S		
Flint clay, Owensville, Mo., Connell pit		C	A	S					C		
Flint clay, Rosebud, Mo., Toelke and Heidel pit			C	A					A		
Diaspore clay, Rosebud, Mo., Brown pit				S	S				VA		C?
Diaspore clay, Owensville, Mo., Connell pit			C	S					C		C
Diaspore clay, Rosebud, Mo., Brown pit			C	S					VA		
Diaspore clay, Owensville, Mo., Sassman pit	S		A	A		S			C		
Diaspore clay, Owensville, Mo., Connell pit			A	S	S				A		
Lower Cretaceous											
White clay, Gordon, Ga., upper bed, Col. Kaol. and Alum. Co.	C	C	A	S							M
Nodular clay, Gordon, Ga., upper bed, Col. Kaol. and Alum. Co.	S		S	S	S						VA
White clay, Dry Branch, Ga., crude, Amer. Clay Co.	S	C	VA	S							
White clay, Dry Branch, Ga., washed, Amer. Clay Co.	S	C	A	S	S						
Allendale, S. Ca., Box pit											
Abbeville, S. Ca., Hill pit	S	S	A	C	S						
White clay, S. W. of Trenton, S. Ca.	A	C	A	S							
Bath, S. Ca. McNamee Kn. Co., 1	C	S	VA	A			S				
Bath, S. Ca. McNamee Kn., Co., 2		M	A	A	S						
White clay, Langley, S. Ca.		C	A	A	S	S					
White clay, Langley, S. Ca.	S	C	VA	A		S					
Upper Cretaceous	S	C	A	A	S			C			
Rayflin, S. Ca., Edisto Kaolin Co.	A	S	A	S	S		S				
White clay, Aiken, S. Ca.	S	S	A	A							
Ripley											
White clay, Perry, Ga., Houston Kaolin Co.	S	S	S	C	S			S			A
White part of mottled clay, Perry, Ga., Houston Kaolin Co.		S	S	S	S	S		S			A
Red part of mottled clay, Perry, Ga., Houston Kaolin Co.	S	S	S	S	S	S					A[d]
Sagger clay, Hollow Rock, Tenn.	C	A	C	C		S					
Sagger clay, Hollow Rock, Tenn.	C	A	A	A	S						
Lignitic clay, India, Tenn.	S	A	C	S							
Brown sandy clay, E. Paris, Currier pit	C	A	A	A		S		S			
Dark clay, E. of Paris, Currier pit	C	A	C	S							

[d] Stained with hematite.

Porter's Creek											
Wad clay, Benton, Ky., Howard pit	C	A	A	A			S				
Wad clay, Benton, Ky, Howard pit	C	A	A	A							
Wad clay, Briensburg, Ky.	C	A	A	S	S						
Wilcox formation											
Andersonville, Ga., Sweetwater mine, white clay		C	A	S							
Andersonville, Ga., Sweetwater mine, mottled clay		S	A	S	S						M?
Enid, Miss., No. 5 pit, Bramlett	C	VA	S	S		S					
Enid, Miss., No. 21 pit, Bramlett	S	A	A	S		S					
Holly Springs, Miss., stoneware clay	C	A	A	C							
Lagrange, Tenn., Dale sand pit, claylens	A	S	A	M	S	S		S			
Lagrange, Tenn., McAnee pit	C	A	A	A	S						
McKenzie, Tenn., No. 10 ball, Johnson-Porter	S	A	A	S		S					
McKenzie, Tenn., No. 11 ball, Johnson-Porter	S	A	A	S							
McKenzie, Tenn., Sparks pit	S	A	A	M		S	S				
Sagger clay, Henry, Tenn., Chrisman and Reynolds	A	A	C	C	S	S					
1 S. G. P. clay, Whitlock, Tenn., Mandle	S	A	C	C		S					
No. 5 Ball, Whitlock, Tenn., Mandle	S	A	C	S							
No. 7 Ball, Whitlock, Tenn., Mandle	S	A	C	S							
No. 4 Ball, white, Whitlock, Tenn., Mandle	S	A	C	A		S					
No. 4 Ball, dark, Whitlock, Tenn., Mandle	S	A	C	S							
Puryear, Tenn., Dixie Brick & Tile Co.	C	C	VA	S	S	S		S			
Wad clay, Hazel, Ky., Cooley Ball and Sagger Clay Co.	C	C	A	C		S					
Dark ball clay, Hazel, Ky., Cooley Ball and Sagger Clay Co.	S	A	C	A	S						
No. 4 Ball, Pryorsburg, Ky., Ky. Constr. & Imp. Co.	S	VA	A	S							
Old No. 4 Ball, Pryorsburg, Ky., Ky. Constr. & Imp. Co.	S	VA	C	A							
No. 5 clay, Pryorsburg, Ky., Ky. Constr. & Imp. Co.	S	C	A	M							
No. 3 Ball, Pryorsburg, Ky., Mayfield Clay Co.	C	VA	A	S		S					
Ball, Pryorsburg, Ky., Mayfield Clay Co.	C	A	A	A		S					
No. 1 Ball, Hickory, Ky., Old Hickory Clay & Talc Co.	S	VA	C	S							
Crude clay, Lester, Ark., Camden Coal and Clay Co.	C	A	A	A	S	S		S			
Washed clay, Lester, Ark., Camden Tertiary	A	A	C	S		S					
Crude, Edgar, Fla.	A	S	A	S	S						
Washed, Edgar, Fla.	S	A	A	S	S						

ters when of larger size, combined with its flaky nature and very often its tendency to combine in fan- or worm-shaped bunches. Low index of refraction and low birefringence separate it from the other micaceous minerals. When fine, it can merely be noted as minute, transparent plates, of an index of refraction close to the balsam, and very low interference color.

The kaolinite occurs as single scales or plates, sometimes in bunches of fan-shaped character, and as vermiculites. In one clay, the Indianaite from Lawrence County, Indiana, spherulite-like bodies were also found.

Specially fine examples of "fans" were noted in the clay from Perry, Georgia, Bynum, Alabama, Bauxite, Arkansas, and Antioch, California.

Good examples of vermiculites were seen in samples from South Carolina, Perry, Georgia, Bauxite, Arkansas, Antioch, California, and the nodular white clay from Gordon, Georgia.

The Florida clay from Okahumpka and Edgar, as well as the samples from Langley and Aiken, South Carolina, showed large single flakes.

Hydromica.—This is a distinctly micaceous mineral, which has single and double refractions higher than those of kaolinite, yet not so high as muscovite or sericite. Furthermore, the degree of these refractions varies in different clays. It is therefore assumed[1] that there is an isomorphous gradation between sericite and kaolinite, with a gradual loss of potash and addition of water, and, in weathering products such as these, hydromica represents a transition stage of weathering toward kaolinite as the final product.

The fan of the hydromica is similar to that of the kaolinite, but it may occur in larger grains. Radiating bunches and spherulite-like grains were found in the white clay from near Huron, Indiana.

COMPARATIVE ABUNDANCE OF KAOLINITE AND HYDROMICAS

Descriptions of the microscopic examination of clays that have appeared from time to time, make frequent reference to kao-

[1] For discussion of hydromica see GALPIN, SYDNEY L. *Studies of flint clays and their associates.* Trans. Am. Ceram. Soc. 14: 306 and 338.

linite, but the presence of mica is less often commented on, and yet, judging from the nature of the clays described in this report, it seems to be quite abundant.

The same might possibly be inferred from the chemical composition of many kaolins which show a small percentage of potash, for since feldspar seems to be very scarce, the former may be regarded as belonging to mica.

Vogt, for example, in 1906, concluded that china clay consisted of kaolinite, muscovite, and quartz, although he based his conclusions on the chemical composition of the material.[2]

Later, Hickling,[3] after studying the china clay of Cornwall, states that in the finest washed clays, kaolinite, mica, quartz, and tourmaline are present, but that the first two make up 90 per cent of the mass. He adds, however, that the relative amounts of kaolinite and muscovite are difficult to estimate.

He differentiates the mica into two classes, *viz*, primary mica and secondary mica derived from feldspar.

He refers to the kaolinite as occurring as irregularly hexagonal prisms, with rough faces, which show strong transverse striations corresponding to the basal cleavage. "These prisms are usually curved, sometimes quite vermiculiform. The shorter prisms commonly present a fanlike arrangement and exactly resemble the similar forms of mica, from which they can be distinguished only by their lower interference tint."

Isolated plates or very short prisms may occur, and then "even with convergent polarized light, it is not easy to judge the amount of birefringence under such circumstances, and, consequently, to decide to which mineral a given fragment belongs; hence the difficulty of estimating their relative proportions. Both kinds show the same irregular form (due probably to development within decaying feldspars) and the same evidence of corrosion on the edges. The low interference-tint and low index of refraction definitely distinguish these crystals from mica.

[2] VOGT, G. *De la composition des argiles.* Memoires publiés par le Societé d'Encouragement pour l'Industrie Nationale, Paris, 1906, pp. 193–218.

[3] HICKLING, G. *China clay. Its nature and origin.* Trans. Inst. Min. Eng. 36. 1908–09.

The identification of kaolinite rests on the following evidence:

(*a*) The index of birefringence is distinctly low, about that of quartz, but variable.

(*b*) The index of refraction is very near to 1.56.

(*c*) The prismatic crystals extinguish parallel to the basal plane.

(*d*) Basal flakes show a biaxial interference figure.

While Hickling refers to the mica as muscovite, he notes that it may be hydrated; indeed he thinks that the muscovite changes directly to kaolinite in the clay, because: 1. He can find mica but no kaolinite in feldspar or in the granite. 2. There is no difference in form between the mica and kaolinite. 3. He finds prisms which are mica at one end and kaolinite at the other.

He also quotes the observations of Johnstone,[4] who found that by exposing muscovite to pure water, and water saturated with CO_2, for 12 months, it had changed to hydromuscovite. This Hickling believes shows a conversion in the direction of kaolinite.

In line with these observations, reference may be made to the work of Galpin[5] on flint clays. In these he found platy masses of what at first appeared to be kaolinite, which frequently show "ribs" or plates of higher index and birefringence intergrown with those of kaolinite, and which ribs show practically every grade of variation between kaolinite and muscovite.

Halloysite.—Two clays, *viz*, those from north of Huron, Indiana, and the Bond-Marks deposit near Beatty, Nevada, contain material in platelike grains, which is isotropic, and is probably to be regarded as halloysite. In no other samples could this material be so definitely identified.

Rutile.—The presence of rutile is interesting, in view of the probable constant occurrence of titanium in high-grade clays. Practically every clay examined shows rutile in some amount. In some cases it is in grains or prisms, perhaps 0.015–0.020 mm. in diameter, when its color and refractive properties distinguish

[4] JOHNSTONE, A. *On the action of pure water and of water saturated with carbonic acid gas on minerals of the mica family.* Quart. Journ. Geol. Soc. 45: 363. 1889.

[5] GALPIN, S. L. *Studies of flint clays and their associates.* Trans. Am. Ceram. Soc. 14: 301, 1912.

it at once. More generally, however, it is found upon close examination as very minute grains or needles which are nevertheless so clear-cut that their refractions can be plainly seen. The interference color is of the first order, but the particles are so small that the actual birefringence is thereby shown to be very high. They vary from perhaps 0.001 mm. to 0.010 mm. in diameter and if in needles are 5 or 6 times as long as they are wide. In number these grains are very abundant, but in actual bulk, they represent a very small quantity of rutile.

Rarer Minerals.—Tourmaline is well marked by its pleochromism, and its frequent occurrence is notable. Epidote is occasionally seen as a slightly greenish mineral of moderate single and double refractions. Grains of both high index and birefringence are common, though not in any abundance, and they prove to be zircon and titanite. A distinction between the two is quite possible by means of the higher interference color of the titanite. Zircon is much the commoner.

Diaspore.—This is easy to determine by its moderately high index and double refraction, and its occurrence in irregular grains. It is quite common in certain of the clays examined from Missouri. Since the diaspore in these clays or their associated rocks sometimes occurs in grains sufficiently large to be seen with the naked eye, it may be mistaken for quartz, but can be separated from it and clay by means of bromoform (sp. gr. 2.8), in which the diaspore (sp. gr. 3.4) sinks, while the associated minerals float.[6]

Texture.—It would be very difficult to standardize clays by size of particle, because any one clay is apt to be made up of particles of all sizes, and because there is no standard to use. Comparing these clays with each other, however, it may be said that relatively coarse grains average 0.100 mm. or more in size, medium grains 0.020–0.025 mm., and fine grains 0.010 mm. or less.

MINERALS IN THE BURNED CLAY

A number of the clays were molded into one-inch cubes. These were all fired for 8 hours up to 950° C. After this one

[6] WHERRY, E. T. *Field identification of diaspore.* Amer. Mineral. 3: 154. 1918.

set was refired for 8 hours to 1,150° C., and a second set for 10 hours to 1,300° C. They were then ground to thin sections and examined under the microscope.

Quartz grains usually stand out with much greater clearness in the burned than in the raw clay, due to the fact that the hydrous aluminum silicates tend to mat or fuse together to a fine-grained ground mass which holds the quartz. In some specimens a fluxing action appears to have taken place between the fine-grained material and the silica, resulting in a corrosion of the quartz, but this is comparatively rare.

Hydromica on heating to 1,150° C. either practically disappears, forming an isotropic mass, or else it loses the greater part of its interference color. The only exception to this was where the hydromica grains were much larger than usual, in which case it was noticed that the central portion of the grains retained usually the original interference color.

This change of the hydromica on heating would seem to suggest that it furnishes some of the flux for the clay, and other things being equal, there may be a connnection between the degree of densification at the temperature mentioned, and the quantity of hydromica present.

Kaolinite when not fluxed, appears to retain its shape and at least a good part of its original interference color. Tourmaline and probably epidote disappear even at 1,150° C., but the rutile, zircon, and probably titanite seem to be unaffected even at 1,300° C. The persistence of the rutile can be plainly seen even through the particles are very small.

Sillimanite was noticed in a Florida white clay fired at 1,300° C., where the conditions happened to be just right for its development. That it has formed from the large flakes of kaolinite or low-grade hydromica is clearly indicated by one composite flake of the two minerals.

The actual reason for its development is not evident, other clays carrying similar micaceous flakes, and burned at the same time, not showing the sillimanite in the burned product.

TABLE 2

FEATURES SHOWN BY THIN SECTIONS OF BURNED CLAY

						1150°C.		1300°C.	
Locality	Texture	Quartz	Hydro-mica	Kaolin-ite	Rutile	Porosity Per cent	Appearance	Porosity Per cent	Appearance
Sagger clay, Hollow Rock, Tenn.	Medium	C[a]	A	A	A			9 1	Micaceous texture remains. Hydromica interference color gone. Groundmass shows mostly kaolinite interference, and very little isotropic material.
White sedimentary clay, granular, Andersonville, Ga.	Very fine		C	A	S	43 7	A fine granular aggregate, about 1/2 isotropic and 1/2 kaolinite interference color	33 1	Similar except it is beginning to develop mottled patches of low interference color.
Benton, Ky	Medium to fine	C	A	A	A			24 5	Hydromica all gone Quartz grains in mostly isotropic groundmass. A few low interference colors.
Enid, Miss.	Medium	C	VA	S	S			0 6	Very fine, dense, felty aggregate. Low interference. Possibly sillimanite.

a For explanation of letters see table 1.

TABLE 2 (*Continued*)

Holly Springs, Miss.	Fine	C	A	A	C	22.6	Hydromica gone. Quartz in fine felty groundmass, partly isotropic and partly low interference color.	13 0	Similar to preceding.
Mayfield clay, Pryorsburg, Ky.	Medium to fine	C	A	A	A	30.0	Hydromica color gone. Quartz in fine-grained groundmass, partly isotropic and partly with low interference color.	24 0	Increase in isotropic material. Rutile visible.
Kaolin, Lutesville, Mo.	Medium	C	A	A	S	14 4	Fine texture, partly isotropic, partly kaolinite interference	0 8	Little different from 1,150°
Kaolin, Saylorsburg, Pa.	Medium	C	A	A	S	21.9		0 5	Quartz in slightly felted groundmass. Some isotropic. Rutile still visible.
Washed kaolin, Saylorsburg, Pa.	Medium to fine	C	A	A	A	5 9	Fine granular aggregate. Some hydromica. Some isotropic material.	0 4	Fine granular aggregate. Hydromica gone. More isotropic material.
Crude kaolin, Saylorsburg, Pa.	Medium to fine	C	C	A	A	31.2	Granular, slightly matted groundmass. Hydromica color gone. Some isotropic material.	2 9	More isotropic material. Rutile persists.

TABLE

Crude kaolin, Mt. Holly Springs, Pa.	Medium	C	C	A	S	10.0	Hydromica gone. Groundmass mostly isotropic. Some kaolinite colors.	2.0	More isotropic material.
Washed kaolin, same places	Fine	C	C	VA	A	19.5	Hydromica gone. Some isotropic.	3.4	More isotropic. Rutile persists.
Kaolin, Pitt-Rowland	Coarse	A	A	A	S	51.1	Most of mica shows kaolinite interference color, except in center. Some isotropic.	30.8	Mica interference color practically all gone. More isotropic.
Kaolin, Adamson-Dickson	Medium	A		A	S	48.9	Not much different in appearance from unburned.	45.2	Not much different in appearance from unburned.
Kaolin, Beatty, Nev. Is mostly halloysite	Fine			S	S	58.2	Fine fibrous aggregate, just starting an interference color.	36.9	Same as preceding but interference color increasing.
White clay, Dry Branch, Ga.	Fine	S	C	VA	S	40.0	Fine-grained mass.	27.6	Fine-grained mass, with low interference color throughout.
White clay, Florida, washed.	Medium to fine	S	A	A	S	38.0	Fine-grained ground mass with much isotropic material, and rest small flakes of low interference.	26.1	Felty appearance, with more interference colors of low order. Some of the larger mica flakes changed to sillimanite.

This development of sillimanite by burning and its possible abundance in porcelain[7] may be the explanation of another feature noted. In some of the clays, as indicated in the descriptions, a double refraction is *produced* in the ground mass of the clay by burning to higher temperatures. It is very probable that this is caused by particles too minute to be easily recognizable, and that the development of the interference color may be due to the formation of sillimanite. The single and double refractions of the material would not be against it, but it is not proven in any way except by analogy.

In the sections where sillimanite was actually determined, it is present in the form of slender crystals of fair size, and can surely be distinguished by its moderate relief, low interference, optical character, and cross fractures.

In table 2 there are given in summarized form the features which a number of the thin sections show. They are worth recording, although the series is not sufficiently large to warrant drawing definite conclusions. For further comparison the table also gives the texture of the clay, relative abundance of the important constituents, and porosity after burning.

CRYSTALLOGRAPHY.—*An unusual sulfur crystal.* F. RUSSELL BICHOWSKY, Geophysical Laboratory. (Communicated by R. B. Sosman.)

The accidental mixing of a hot alcoholic solution of ammonium polysulfide with a mixture of benzonitrile, hydroxylamine hydrochloride, and ether resulted, among other things, in the formation of the single, well-developed, orange-red, translucent crystal figured below. The crystal was measured and figured (Fig. 1) under the impression that it was a crystal of some organic compound, but later analysis showed that it was almost pure sulfur containing 0.33 per cent carbon, 0.09 per cent hydrogen, 0.10 per cent nitrogen, 0.07 per cent ash, and a trace of chlorine. The density 2.01 is not unusual for sulfur, and the angles are in close accord with those calculated, using the Goldschmidt[1]

[7] KLEIN, A. A. *The constitution and microstructure of porcelain.* Trans. Am. Ceram. Soc. 18: 377. 1916.

[1] GOLDSCHMIDT. Krystallographische Winkeltabellen, p. 313. Berlin, 1897.

axial ratios 0.8138 : 1 : 1.9055. The crystal was about 6 mm. long and weighed 0.27 gram. The following faces were observed (both the Miller and Goldschmidt symbols are given in order): *c*, (001), 0; *b*, (010), 0 ∞ ; *a*, (100), ∞ 0; *e*, (101), 10; *m*, (110), ∞ ; *v*, (013), $0^1/_3$; *n*, (011) 01; *s*, (113), $^1/_3$; *y*, (112), $^1/_2$; *p*, (111), 1; *γ*, (331), 3; *r*, (311), 31; *ζ*, (211), 21; *q*, (131), 13; *k*, (120), ∞ 2; *h*, (130), ∞ 3; *λ*, (210), 2 ∞ ; *ρ*, (310), 3 ∞. Of these the faces *ζ*, (211), 21, and *ρ*, (310), 3 ∞, are new. The larger faces *m*, *p*, and *c* were all somewhat pitted and striated and often gave double signals. The other faces all gave first quality signals with the exception of faces *γ* and *ζ* which in the instruments used gave but faint (though well-defined) ones. Faces *γ* and *ζ* occurred but once, the first as a narrow imperfect bevelling of the edge (111)–(110), the second as a linelike but perfect face bevelling the edge (100)–(311). The remaining faces occurred the theoretical number of times, except faces *λ* and *ρ* which occurred three instead of four times each.

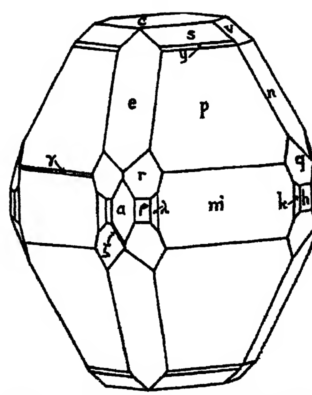

Fig. 1. An unusual sulfur crystal.

The most unusual feature of this crystal is the well-developed zone [001] containing the brachy- and macro-pinacoids *a* and *b* (2 times each), the primary prism *m* (4 times), the rare macro-prisms *k* and *h* (4 times), the rare brachy-prism *λ* (3 times)[2] and the new *ρ* face (3 times). Another interesting zone is the oblique zone [01$\bar{1}$] containing the faces *n*, *p*, *r*, *ζ*, and *a*. The corresponding zone [10$\bar{1}$] is less well developed.

The zonal relations of the crystal are in themselves sufficient to establish the symbols of the new faces, but as a check the crystal was carefully measured on a makeshift one-circle goniometer using reflections from different parts of the faces and reading on different parts of the circle. The results agreed closely with

[2] Given by GOLDSCHMIDT, loc. cit. I have been unable to find the original reference.

those calculated from the Goldschmidt axial ratio. The angles for the rarer faces are: (010)–(130), measured 22° 18′, calculated 22° 16′; (010)–(120), measured 31° 33′, calculated 31° 34′; (010)–(210), measured 67° 51′, calculated 67° 51′; (010)–(310), measured 74° 48′, calculated 74° 49′; (011)–(211), measured 65° 30′, calculated 65° 19′.

Table 1 contains a complete list of the faces reported for rhombic sulfur, their discoverer, Miller and Goldschmidt symbols, principal Goldschmidt position angles, and the number of times reported in the literature examined.

TABLE 1

FACES OBSERVED ON RHOMBIC SULFUR

$a = 0.8138$
$c = 1.9055$

Miller symbols		Goldschmidt symbols	Discoverer	Goldschmidt Angle φ	Goldschmidt Angle σ	No. of times reported
c	001	0	Romé de l'Isle[1]		0°00′	48
b	010	0∞	Scacchi[3]	0°00′	90 00	28
n	011	01	Romé de l'Isle[1]	0 00	62 18·	41
v	013	0 1/3	Brooke-Miller[4]	0 00	32 25·	18
w	023	0 2/3	Brooke-Miller[4]	0 00	51 47·	2
θ	031	03	Molengraaf[10]	0 00	80 04·	3
ξ^c	043	0 4/3	Buttgenbach[18]	0 00^b	72 38·	1
a	100	∞0	Romé de l'Isle[1]	90 00	0 00	16
e	101	10	Mohs[2]	90 00	66 52·	26
π^c	102	1/2 0	Buttgenbach[18]	90 00^b	49 30	1
u	103	1/3 0	Brooke-Miller[4]	90 00	37 58·	14
m	110	∞	Mohs[2]	50 51·	90 00	33
p	111	1	Romé de l'Isle[1]	50 51·	71 40·	72
y	112	1/2	Scacchi[3]	50 51·	56 28	23
s	113	1/3	Mohs[2]	50 51·	45 10·	51
o	114	1/4	Fletcher[8]	50 51·	37 02·	8
t	115	1/5	Mohs[2]	50 51·	31 07·	29
i^c	116	1/6	Buttgenbach[18]	50 51·^{b}	26 42·	2
ω	117	1/7	Brezina[6]	50 51·	23 19·	9
ψ	119	1/9	Zapharovich[5]	50 51·	18 32·	7
	1.1.11?	1/11	Schmidt[15]	50 51·^{b}	15 21	1
	1.1.14?	1/14	Schmidt[15]	50 51·^{b}	12 10	1
	1.1.17?	1/17	Schmidt[15]	50 51·^{b}	10 4	1
k	120	∞2	Brooke-Miller[4]	31 34	90 00	3
κ	122	1/2 1	Pelikan[13]	31 34	65 54·	1
h	130	∞3	Weed & Pirsson[12]	22 16·^{b}	90 00	1
q	131	13	Brezina[6]	22 16·	80 48·	19
x	133	1/3 1	Scacchi[3]	22 16·	64 06	18

TABLE I (*Continued*)

z	135	1/5 3/5	Brooke-Miller[4]	22 16˙	51 01	16
F	151	15	Busz[14]	13 48˙	84 11	1
Λ[c]	155	1/51	Millosevich[16]	13 48˙[b]	63 30	1
τ[c]	201	20	Buttgenbach[18]	90 00[b]	78 13	1
λ	210	2	Goldschmidt[17]	67 51˙	90 00	1
ζ[c]	211	21	Bichowsky	67 51˙	78 48˙	1
δ	221	2	Molengraaf[10]	50 51˙	80 35˙	6
ν[c]	227	2/7	Buttgenbach[18]	50 51˙[b]	40 47	1
	229?	2/9	Buttgenbach[18]	50 51˙[b]	33 51	1
φ	305	3/50	Millosevich[16]	90 00[b]	54 33˙	1
ρ[c]	310	3 ∞	Bichowsky	74 49[b]	90 00	1
r	311	31	Brezina[6]	74 49[a]	82 10˙	7
α	313	1 1/3	Molengraaf[10]	74 49[a]	67 36	13
β	315	3/5 1/5	Dana[9]	74 49[a]	55 30˙	7
μ	319	3/9 1/9	Millosevich[16]	74 49[b]	38 58	1
γ	331	3	Friedländer[7]	50 51˙	83 42	14
f	335	3/5	Busz[11]	50 51˙[b]	61 06	3
g	337	3/7	Busz[11]	50 51˙[b]	52 18	2
	3, 3, 16?	3/16	Buttgenbach[18]	50 51˙[b]	29 39	1
l	344	3/41	Brezina[6]	42 40	68 54	1
ε	551	5	Busz[14]	50 51˙	86 12˙	2
η	553	5/3	Busz[14]	50 51˙	78 35˙	1

[a] Corrected value. Goldschmidt gives the erroneous value 74° 39′.

[b] New calculation.

[c] New symbol.

The symbol ˙ indicates 1/2′.

1 Romé de l'Isle. Crystallogr. 1: 289. 1783.

2 Mohs. Mineralogy, Edinburgh 3: 52. 1825.

3 Scacchi. Mem. Geol. Campan., Rend. Ac. Nap. (1849), 103; Zts. D. Geol. Ges. 4: 168. 1852.

4 Brooke-Miller. Mineralogy 109. 1852. (Quoted from Brezina. [6])

5 Zapharovich. Jahrb. Geol. Reichsanst. 19: 229. 1869.

6 Brezina. Akad. Wiss. Wien. 60: 539. 1869.

7 Friedländer. Min. Sammlung Strassburg, 262. 1878. (Quoted from Dana, System of Mineralogy.)

8 Fletcher. Phil. Mag. V. 9: 186. 1880.

9 Dana. Amer. Journ. Sci. 32: 389. 1886.

10 Molengraaf. Zeitschr. Kryst. Min. 14: 45. 1888.

11 Busz. Zeitschr. Kryst. Min. 17: 550. 1890.

12 Weed and Pirsson. Amer. Journ. Sci. 42: 401. 1891.

13 Pelikan. Tscherm. Min. Petr. Mitt. 12: 344. 1891.

14 Busz. Zeitschr. Kyrst. Min. 20: 560. 1892.

15 Schmidt. Zeitschr. Kyrst. Min. 29: 210. 1898.

16 Millosevich. Atti Accad. Lincei 7: 2 Sem.: 249. 1898.

17 Goldschmidt: Quoted in Krystallographische Winkeltabellen, Berlin, 313. 1897.

18 Buttgenbach. Ann. Soc. Geol. Belg. Liege (1898), 25 Mem. 73.

Figure 2 is a stereographic projection of the known faces. The dots representing the known faces have an area proportional to number of times reported. This figure emphasizes the more important zonal relations of sulfur and particularly the predominance of the primary pyramid zone [1$\bar{1}$0]. The brachy- and macro-dome zones [$\bar{1}$00] and [0$\bar{1}$0], as well as the oblique zones [101] and [011], are also well developed. Among the lesser zones sulfur shows a curious preference for zones (and faces)

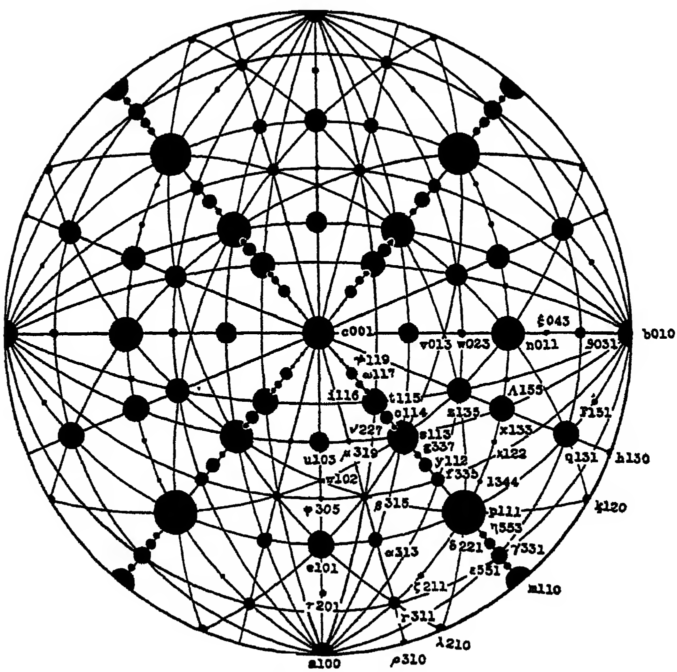

Fig. 2. Stereographic projection of the known faces of sulfur crystal.

with an intercept ratio involving an odd number such as 3, as compared with those involving an even number such as 2. Compare the development of the zones [$\bar{1}$30], [3$\bar{1}$0], [$\bar{1}$03], [30$\bar{1}$], [03$\bar{1}$], [0$\bar{1}$3], with the corresponding zones [$\bar{1}$20], etc. The poor development of zones, except [110], having (110) as a pole is interesting. The usual rule that faces at the intersection of important zones are likely to be most commonly developed is

well emphasized in sulfur, as are certain quantitative relations, but the number of sulfur crystals reported is too small to make quantitative relations of much value.

MINERALOGY.—*Plancheite and shattuckite, copper silicates, are not the same mineral.* WALDEMAR T. SCHALLER, Geological Survey.

The name plancheite was given by Lacroix,[1] in 1908, to a blue copper silicate from the French Congo, Africa. About five years later a blue copper mineral from Bisbee, Arizona, sent to the U. S. Geological Survey for identification, by Philip D. Wilson, of Bisbee, was determined by qualitative tests as probably plancheite. Abundant material was available for various determinations and it was soon found that several discrepancies existed between the properties of the two minerals from Arizona and from Africa. Accordingly a detailed investigation of the Arizona material was undertaken and it was determined that the Arizona mineral was not plancheite and that an additional new copper mineral was intimately associated with and genetically derived from the more abundant blue mineral, which in a preliminary note[2] was named shattuckite, the other new copper mineral being called bisbeeite. So far as known to the writer, plancheite has not been found in Arizona. The essential properties of shattuckite and of bisbeeite were published in the Third Appendix to Dana's System of Mineralogy. The paper describing in detail the properties of these two new copper silicates has not yet been published.

Zambonini[3] has recently questioned the validity of shattuckite as a separate species and has urged its identity with plancheite. He gives a new analysis of plancheite which does not agree with

[1] LACROIX, A. *Sur une nouvelle èspece minéral, provenant du Congo français.* Compt. Rend. 146: 722–725. 1908; *Les minéraux accompagnant la dioptase de Mindouli (Congo français): plancheite, nov. sp.* Soc. Franç. Minéral. Bull. 31: 247–259. 1908.

[2] SCHALLER, W. T. *Four new minerals.* Journ. Wash. Acad. Sci. 5: 7. 1915.

[3] ZAMBONINI, F. *Sur l'identité de la shattuckite et de la plancheite.* Compt. Rend. 166: 495–497. 1918.

the original one, but which does agree with the analyses of shattuckite. Explanations of his results are suggested at the close of this paper.

The nonidentity of shattuckite with plancheite, notwithstanding their very close resemblance in properties and in chemical composition, was definitely determined before the name shattuckite was proposed. The direct comparison of the two minerals was readily made, as Prof. Lacroix had kindly presented to the writer in Paris in 1912 a typical specimen of plancheite. The available specimen could not yield a sample of plancheite of the requisite purity for chemical analysis. Plancheite is intimately mixed with other copper silicates, the most abundant of which in the single specimen examined, is what is ordinarily called chrysocolla. A set of three thin sections of parts of the plancheite specimen shows that probably several other copper silicates are also present, although the two named are predominant. The fibers and spherulites of plancheite are imbedded, in places, in the massive pale green chrysocolla and the other copper silicates. The thin sections also show that although small fairly pure masses of plancheite spherulites occur in the rock, these masses are bordered by a layer of some other copper mineral Judging only from the single specimen, it would be most difficult, if not impossible, to prepare even a very small sample of nearly pure plancheite for chemical analysis.

Abundant shattuckite was available, from which samples were prepared that after careful selection contained only small amounts of included tenorite. The analyses of three different samples of shattuckite establish its formula as $2CuO.2SiO_2.H_2O$; whereas the formula of plancheite, as revised, is given as $6CuO.5SiO_2.2H_2O$ (the original formula proposed is $15CuO.12SiO_2.5H_2O$).

If the only quantitative basis for determining the question of the supposed identity of shattuckite with plancheite were the chemical analyses, then the two minerals would readily be considered as identical. But there is a simple and absolutely conclusive method by which the question as to the identity of the two minerals can be answered. This is by a comparison of their

optical constants, of which the refractive indices are the easiest determined. If the refractive indices show a distinct difference, then the minerals are not the same.

The refractive indices of both minerals were determined by the writer before any mention of shattuckite was published and it was found that the lowest refractive index (α) of shattuckite was considerably higher than the highest (γ) refractive index of plancheite. The actual determinations are shown in table 1; there are also given the independent determinations kindly made by E. S. Larsen, of the U. S. Geological Survey. Mr. Larsen's values are more accurate than those of the writer and should be taken as the correct values. The accurate determinations of the refractive indices of such finely fibrous minerals as those under discussion is an operation requiring very careful work and considerable experience.

As table 1 readily shows, there is sufficient difference in the optical constants of shattuckite and plancheite to preclude their being identical.

TABLE 1

REFRACTIVE INDICES OF PLANCHEITE AND SHATTUCKITE

Index	Plancheite				Shattuckite	
	Lacroix [a]	Larsen [b]		Schaller	Larsen	Schaller
α	n.d.	1.645	1.640	1.644	1.752	1.730
β	n.d.	1.660	n.d.	n.d.	1.782	n.d.
γ	1.70	1.715	1.697	1.702	1.815	1.796

[a] Stated to be near 1.70 (γ), LACROIX, A. Minéral. France 4: 758. 1910.
[b] Two sets of determinations, made at different times.

Zambonini's analysis of plancheite yields the same formula as has been derived for shattuckite and he naturally concludes that the two minerals are the same. Two suggestions are offered: (1) that, through inadvertence, the mineral furnished Zambonini (obtained from Lacroix in Paris) really was shattuckite and not plancheite. This suggestion could have been readily proved or disproved by a determination of the refractive indices of the

material analyzed; (2) the material analyzed (plancheite) contained enough impurities (copper silicates) to affect the composition of the sample so that the results obtained are comparable to the composition of shattuckite.

But whatever may be the exact chemical relations of these two minerals and whatever may be the formula of plancheite the difference in the refractive indices proves conclusively that they are not the same.

PALEONTOLOGY.—*Description of a supposed new fossil species of maize from Peru.* F. H. KNOWLTON, U. S. National Museum.

Some months ago the United States National Museum came into the possession of a very remarkable specimen of fossil corn from Peru. It was sent in as an ethnological specimen, having been secured from a dealer in curios in the city of Cuzco, Peru, by Dr. W. F. Parks, of St. Louis, Missouri. Dr. Walter Hough, of the Division of Ethnology in the National Museum, brought the specimen to me for identification. Although it is wonderfully well preserved, it is in many particulars so different from the ordinary types of corn with which I was familiar that its affinity was not recognized until this was pointed out by Mr. G. N. Collins, of the U. S. Department of Agriculture, who for many years has been making a special study of the origin, evolutionary history, and distribution of Indian corn (Zea).

Fig. 1. Fossilized ear of corn.

The specimen has suffered practically no distortion during fossilization, though a portion of the apex has been broken off and lost. It is now a little more than 6 centimeters in length and was probably about 8 centimeters long when complete. The greatest diameter is nearly 4 centimeters. The point of attachment for the "ear" was very small, suggesting that it

was perhaps drooping, unless it was held upright by the developing leaves. The axis or "cob" has entirely disappeared so far as any structural elements are concerned, and its place has been filled by a closely cemented, fine-grained siliceous sand. The individual kernels or grains of corn are mostly roughly triangular in shape, and markedly different in size. The grains are not arranged in vertical rows but in some parts of the ear there is evidence of their being in diagonal rows, though this is perhaps accidental. When viewed as a whole the grains appear to be very irregularly placed. In color the grains are dark brown, almost black, and as the matrix replacing the axis is light yellow in color, the grains stand out in strong relief. No structural or cellular elements are retained in the interior of the grains, this being filled with very fine-grained compact sand.

Now the question arises as to the name by which this unique specimen should be known. It must be confessed at once that it proves exceedingly difficult, if not, indeed, impossible, to find characters by which it can be adequately separated from certain living types, such, for instance, as the Copacabana variety from the regions of Lake Titicaca, yet the fact that it is so completely fossilized lends support to the probability of its being several thousand years old instead of a few hundred years. For this reason alone, and in order that it may be independently referred to, I venture to give it the name *Zea antiqua*.

It is of course extremely unfortunate that nothing is known as to the condition under which this specimen was found. If this were known it might be possible to fix its age with a reasonable degree of certainty. As it stands, however, there is little but the fact of its thorough fossilization to base an opinion on, and from this I venture the tentative suggestion that it seems hardly likely to be younger than at least several thousand years. In a recent paper on "The evolution of maize," by Paul Weatherwax,[1] he says: "Geology and archaeology are of little value to us in solving these problems, since the oldest remains of these plants found in the rocks or in human habitations are practically modern."

[1] Bull. Torrey Club 45: 334. 1918.

It seems to me that the specimen under discussion falls very little short of supplying the needed paleontological data on the antiquity of maize. Its very modern appearance may of course readily be interpreted as an indication of its comparatively recent age, but, on the other hand, there is more than a reasonable conjecture that it could be actually as old as has been suggested, in which case it shows that the real ancestors of maize must apparently be sought much earlier than has usually been assumed.

ZOOLOGY.—*The systematic position of the crinoid genus Holopus.* AUSTIN H. CLARK. U. S. National Museum.

The systematic position of *Holopus* has never been definitely determined. In the latest general work on the Crinoidea[1] it was placed by Springer and Clark at the end of the Articulata, in Family 8, Holopidae, beyond Family 7, Eugeniacrinidae, and Family 6, Saccocomidae; but this disposition was admittedly provisional.

Holopus has frequently been associated with *Edriocrinus*, but it does not seem possible that the two can really be closely related.

In *Holopus* the disc, arms, and pinnules are so obviously of the same type as those of the pentacrinites and comatulids that the relationship with these forms can scarcely be denied. The arms of *Holopus* are very short and thick and closely appressed against each other; comparison, therefore, must be with the closely appressed arm bases of such types as *Endoxocrinus* or the genera of the Charitometridae (especially *Crinometra*) and not with the distal portions of the pentacrinite or comatulid arms, or with the widely separated arms of many forms. The asymmetry of *Holopus* is duplicated in many of the Comasteridae.

The disc of *Holopus* is identical in character with that of the very young of the comatulids in which perisomic plates are present—*Comactinia*, *Comissia*, *Thaumatocrinus*, and *Pentame-*

[1] Zittel-Eastman's "Paleontology," 1913, p. 241.

trocrinus—even to the detail of the slight eversion of the edges of the orals.

So far as I can see, the column of *Holopus* is composed of radials only. In the young specimen figured by Alexander Agassiz the uniformity of the ornamentation on the outer ring appears to indicate that it is composed of a single series of plates, which must be the radials. In one of the specimens figured by P. H. Carpenter[2] the series of tubercles running down the median line of each sector of the column indicates that the same plate (the radial) persists as far as this ornamentation extends, and probably also to the circumference of the basal disc.

An analysis of all the available characters[3] indicates that *Holopus* occupies practically the same developmental plane as the pentacrinites and the comatulids; indeed it is questionable which of the three groups should be considered the most specialized.

My personal opinion is that the pentacrinites, the comatulids, and *Holopus* are very closely related, in spite of their extraordinary superficial dissimilarity.

In the pentacrinites the column is enormously developed; so rapid is the growth that the proximales as they are continuously formed beneath the calyx never succeed in becoming attached to it, but are continuously pushed outward by the formation of new proximales between the last formed and the calyx; the proximales later become separated by the intercalation of other columnals, appearing in the fully developed column as the cirriferous nodals. The basals are much reduced and lie horizontally.

In the comatulids a short column is formed and a proximale appears which, becoming firmly attached to the calyx, increases enormously in size and, the larval column being discarded, contains the entire adult stem. The basals, in nearly all the types, become metamorphosed into an internal septum and entirely lose their original character. The base therefore is entirely com-

[2] *"Challenger" Report, Stalked Crinoids*, 1884, plate III, fig. 1.

[3] *Phylogenetic study of the recent crinoids......*, Smiths. Misc. Coll. 65: No. 10. August 19, 1915.

posed of radials, practically horizontal in position, plus the proximale.

In *Holopus* the same line of specialization has apparently been followed further; the column and the basals have disappeared, and the attachment is by means of the radials, which in the comatulids dominated the base. It is conceivable that the very young *Holopus* is essentially like a short-stemmed comatulid in which the radials, growing very rapidly, form a cylindrical ring with the basals, spread outward until they all lie in the same plane, closing the proximal end, and that this ring becomes attached by its lower border to the object upon which the larva rests.

ANTHROPOLOGY.—*A second archeological note.*[1] TRUMAN MICHELSON, Bureau of American Ethnology.

Nearly three years ago I showed in this JOURNAL[2] that the provenience of the gray sandstone pipe discussed by Squier and Davis in their *Ancient monuments of the Mississippi Valley*, pages 249 and 250, must be the upper Mississippi region near the Rock River because the original of the pipe figured there is either the same as that of the Sauk pipe shown on plate 2 at the end of volume 2 of Beltrami's *Pilgrimage*, or it belongs to the same culture. It will be recalled that previously there was uncertainty as to the provenience of this pipe. I now find that the lowest of the three pipes shown on the plate facing page 279 of Em. Domenech's *Voyage pittoresque*, said to be from Tennessee, is also of the same culture; indeed it is almost impossible not to believe that the same artist fashioned all three pipes, so great is their likeness.

[1] Published with the permission of the Secretary of the Smithsonian Institution.
[2] 6: 146. 1916.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

INORGANIC CHEMISTRY.—*Note on the sintering of magnesia.* JOHN B. FERGUSON. Journ. Amer. Ceram. Soc. 1: 439–440. June, 1918.

The sintering of chemically pure magnesia has been generally regarded as difficult if not impossible, and this note is intended to place upon record the conditions under which such a sintering was found to take place readily. Pure magnesia powder, upon prolonged heating at temperatures ranging from 1600° to 1720° C., sinters to a cake of considerable mechanical strength and this sintering is due to a recrystallization, forming a mass of interwoven crystals, rather than to the presence of any bonding materials. J. B. F.

ENTOMOLOGY.—*Origin of the castes of the common termite,* Leucotermes flavipes *Kol.* C. B. THOMPSON. Journ. Morph. 30: No. 1. 1917.

Termites, since they belong to that most interesting group known as "social insects," have been studied with interest by entomologists for many years. One of the most important unsolved problems in the complex life cycle of termites has been the origin of the castes.

There have been two theories as to the origin of the castes. According to most of the older writers, all the young are undifferentiated or alike upon hatching, and only become differentiated later through the external influences of food or protozoan parasites; the other view is that the castes are predetermined in the egg or embryo by intrinsic factors.

Dr. Thompson shows that the fertile and sterile types are predetermined at the time of hatching and may be distinguished by the bulk of the brain, the relative size of brain and head, the structure of the compound eyes, and the size of the sex organs. He also proposes a simplification in the nomenclature of forms and castes in termites and in this and a previous paper on the origin of the frontal gland in termites. T. E. SNYDER.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY OF WASHINGTON

The 809th meeting of the Society was held at the Administration Building of the Carnegie Institution, November 23, 1918; Vice-President HUMPHREYS in the chair; 50 persons present.

Mr. W. F. MEGGERS presented the first paper on *Photography of the red and infra-red solar spectrum*. This paper was illustrated by lantern slides.

Ordinary photographic plates stained with dicyanin have been used extensively for several years at the Bureau of Standards in recording the arc spectra of metals and tube spectra of gases in the red and adjacent infra-red spectral regions. The spectra of about half of the chemical elements have thus been investigated from the yellow at wave-lengths of about 6000 A into the infra-red to about 9000 A, and in some cases to wave-lengths greater than 10,000 A.

This success in photographing the long waves from artificial sources suggested an attempt to photograph the infra-red solar spectrum on dicyanin stained plates, for, up to the present time, no complete or accurate determinations of wave-lengths corresponding to Fraunhofer lines in the infra-red have existed, and there have been scarcely any reliable measurements in spectra of the chemical elements in this same region; identifications of absorption and emission lines have, therefore, been few and uncertain.

This work was first undertaken at the Johns Hopkins University in April, 1917, and a brief account of it was published in the Astrophysical Journal[1] together with a map of the solar spectrum from 6860 A to 9600 A. Over 2000 Fraunhofer lines were measured between wave-lengths limits and about 400 of them were identified with emission

[1] MEGGERS. Astrophys. Journ. 47: 1. 1918.

lines in the spectra of twenty of the chemical elements. Nearly 80 per cent of the total number of lines remained unidentified, and many of these, in addition to the well-known absorption bands A and B, due to oxygen in the earth's atmosphere, were suspected to be of terrestrial origin. An opportunity to separate the solar from the telluric lines by aid of the Doppler-Fizeau displacement suffered by lines of solar origin came with an invitation to use the Porter spectrograph at Allegheny Observatory. Light from the eastern and western limbs of the sun was photographed simultaneously in two parallel spectra in which all lines of solar origin appear displaced in opposite directions, while those due to absorption in the earth's atmosphere have the same wave-lengths in both spectra. The spectrograms show that about 75 per cent of the absorption lines with wave-lengths between 6400 A and 9400 A arise in the atmosphere of our earth.

A line (wave-length 7664 A) characteristic of potassium is under ordinary circumstances exactly coincident with one of the lines in the A band due to terrestrial oxygen, but was compelled to betray its solar origin by means of the Doppler-Fizeau effect. The presence of free oxygen in the solar atmosphere was demonstrated by the coincidence of six solar lines with lines in the emission spectrum of oxygen. All of the evidence for solar oxygen lies in its infra-red spectrum.

Discussion: This paper was discussed by Messrs. Sosman and Humphreys.

The second paper on *The hot spell of August, 1918*, was presented by Mr. A. J. Henry.

The hot spell of the first decade of August, 1918, had its origin over Montana and the central and northern Plains States. It was practically stationary over eastern Kansas and western Montana from the 1st to the 3d, inclusive, and on the 4th spread eastward by way of the Ohio valley to western Pennsylvania and also northeastward into the southern part of the Lake region. On the 5th it reached its greatest geographical extension; the area affected on the evening of that date was a little more than a million square miles, or just about one-third of the area of the United States, excluding Alaska and outlying possessions. The increase in the area of the heated territory from the 4th to the 5th was in round numbers a quarter of a million square miles. The peak of the high temperature in the west was reached on August 3–5 and in the east on August 6–7. In the east the daily maxima declined irregularly until the 14th, when normal conditions were reached. The period of extraordinarily high temperature was short, not exceeding three days at any one place. The high temperatures were associated with a dry atmosphere and there was therefore not much bodily discomfort and but few heat prostrations were reported in the daily press.

The abnormally high temperature was due to a combination of favorable circumstances. These in the order of their importance are: (1) A pressure distribution that inaugurated and maintained a system of southerly winds over the great interior valleys and the middle Atlantic

States. (2) The prolonged period of high temperature over the Plains States preceding the hot spell. (3) The absence of clouds and consequently unhindered insolation throughout the period of the hot weather.

Diagrams were shown illustrating the pressure distribution in the United States at the beginning of the hot spell and its daily eastward advance to the Atlantic.

The eastern limit of the hot weather corresponded roughly with the 72d meridian of west longitude, which it may be remembered passes through central Massachusetts.

Local thunder showers set in over the upper Ohio valley, the northern portion of the Appalachian region, western Maryland, and the District of Columbia in the later afternoon of the 7th, bringing to an end in those districts the unusually high temperatures that had prevailed during the preceding 48 hours. While high maxima were recorded in eastern Pennsylvania, eastern New York, and western New England on the 7th, local showers on the 8th brought relief from the extremely high maxima but normal temperatures were not reached in the east until the 14th.

Discussion: This paper was discussed by Messrs. WHITE, KIMBALL, HUMPHREYS, KADEL, and HAYFORD.

The 810th meeting, being the 48th annual meeting of the Society, was held at the Administration Building, Carnegie Institution, December 7, 1918; President Burgess in the chair; 22 members present.

The report of the Secretaries was read by Mr. E. C. CRITTENDEN. This report showed that the present active membership is 182, a net gain of 12 during the past year. Among the active members there were seven deaths during the year, namely: HENRY ADAMS, THOS. B. FORD, G. K. GILBERT, R. A. HARRIS, ARTEMAS MARTIN, RICHARD RATHBUN, GEO. M. SEARLE. Also one member on the absent list, Captain ERNEST WEIBEL, died of wounds received in France. There was one resignation during the year and thirteen were transferred to the absent list, a number of these being men who were engaged in overseas military duty. There were 33 new members elected during the year.

The Society held 14 meetings for the presentation of papers. At these meetings 33 communications were presented. About 15 per cent of the Society presented papers. The average attendance at the meetings was 45, constituting about 25 per cent of the membership of the Society.

The General Committee adopted new By-laws on December 22, 1917, to supplement the revised By-laws of the Society which had been adopted November 24, 1917. These By-laws have been published and issued to the members of the Society.

The report of the Secretaries was accepted and ordered placed on file.

The report of the Treasurer was read by Mr. E. F. MUELLER. This report shows that the receipts from dues, interests on investments, and miscellaneous items amounted to $1,194.96. The expenses for the same period, including expenses of the officers, programs, hall for meetings, and grants, amounted to $804 34. In addition, the Cosmos Club bond of $1,000 was paid and a Chicago, St. Paul and Minneapolis Railway bond was purchased for $1,065.50. The balance on hand December 6, 1918, is $509.25, being $325.12 greater than the balance on hand one year previous. The par value of the securities held by the Society is now $12,500, being the same as one year previous. A list of the securities held by the Society is attached to the Treasurer's report, as is also a list of delinquent dues and the estimated liabilities of the Society. The excess of income over expenditures for 1918 is shown to be $377.38.

The Auditing Committee reported that it examined the books of the Treasurer and found the Treasurer's report to be a correct statement of the resources and liabilities of the Society.

The reports of the Auditing Committee and Treasurer were ordered accepted and placed on file.

The report of the Tellers, consisting of Messrs. D. R. HARPER and R. M. WILHELM, was read by Mr. HARPER. A total of 42 ballots was received. Following the report of the Tellers, the Society proceeded to the election of a President, two Vice-Presidents, Recording Secretary, and two members of the General Committee. The result of election is as follows: *President*, W. J. HUMPHREYS; *Senior Vice-President*, R. B. SOSMAN; *Junior Vice-President*, R. L. FARIS; *Recording Secretary*, S. J. MAUCHLY; *Treasurer*, E. F. MUELLER; *General Committee*, H. H. KIMBALL, F. E. FOWLE, and D. L. HAZARD, to fill unexpired term of Mr. SWANN.

H. L. CURTIS, *Recording Secretary*.

The 811th meeting was held at the Administration Building of the Carnegie Institution, January 4, 1919; President HUMPHREYS in the chair; 72 persons present.

The evening was devoted to hearing the address of the retiring President, Mr. GEORGE K. BURGESS, on *Science and the after-war period*. The address was published in this JOURNAL.[1]

S. J. MAUCHLY, *Recording Secretary*.

BOTANICAL SOCIETY OF WASHINGTON

The 130th regular meeting of the Society was held at the Cosmos Club at 8 p.m., Tuesday, October 1, 1918. Thirty-two members and three guests were present. The following paper was presented:

The eradication of the citrus canker: KARL F. KELLERMAN. Since the autumn of 1914 the Bureau of Plant Industry of the U. S. Department of Agriculture has been cooperating with the Gulf States in a

[1] 9: 57–70. 1919.

campaign for the eradication of the canker disease of citrus fruit and trees. The first observation regarding a plant disease which presumably was citrus canker is with reference to nursery stock introduced into Texas in 1911. It is not improbable that earlier shipments of nursery stock were infected, and it is certain that many later shipments of *Citrus trifoliata* orange seedlings from Japan, both into Texas and into other Gulf States, were infected.

Citrus canker is primarily a leaf-spot and fruit-spot, although it also affects twigs and even old bark and wood. In its early stages, however, it resembles the sour-scab of citrus trees, a troublesome but not an especially serious disease that is widely prevalent in the South. Until late in the year 1913 plant pathologists and nurserymen did not clearly distinguish between these two diseases, and, therefore, prior to its recognition and the determination of its serious character, the shipment of infected nursery stock was probably taking place throughout the southern areas where citrus culture was being extended.

During the seasons of 1913 and 1914 special efforts were made by State nursery inspectors, by nurserymen, and by citrus growers to check the spread of the disease by complete defoliation of infected stock followed by immediate and thorough spraying with strong Bordeaux mixture and by painting visible infections with Bordeaux paste. These treatments were ineffectual, however, and citrus growers in southeastern Florida became so concerned over the rapid and destructive spread of citrus canker and the failure of the methods usually employed for controlling plant diseases that they originated the plan of spraying infected trees with burning oil, thus completely destroying them. Eradication work of this character was undertaken immediately and financed almost entirely by private subscriptions, but the disease appeared to be gaining upon the forces attempting to control it.

Severe tropical storms, in addition to the usual means of spreading the contagion, considerably increased the number of properties infected. The grapefruit, the orange, the lime, and the lemon are so readily infected with citrus canker that it does not appear probable that any method except that of complete destruction of all infected trees will serve to check the disease in any locality. Even at the worst, however, but a very small fraction of the citrus properties of the South have been infected, and those in California have escaped completely. Furthermore, the infected properties usually can be cleansed of the disease before many trees are lost.

Throughout the last three years great emphasis has been given to the necessity of unusual precautions and constant care to prevent the spread of canker, which is extremely infectious to all kinds of citrus trees. The progress of the work has been very satisfactory, and there appears to be no doubt that the few infections occurring in South Carolina and Georgia have been eradicated, so that further work in these states will not be necessary. The amount of infection in Florida, Alabama, Mississippi, Louisiana, and Texas has been very greatly reduced, and while very thorough scouting and inspection will be neces-

sary in these States, in order promptly to locate scattered infections which may occur, it is believed that further seriously destructive outbreaks of canker can be prevented.

The 18th annual meeting of the Society was held immediately after the regular meeting. In the absence of the regular officers, all reports were omitted. The following officers were elected for the ensuing year: *President,* KARL F. KELLERMAN; *Vice-President,* C. R. BALL; *Recording Secretary,* CHAS. E. CHAMBLISS; *Corresponding Secretary,* R. K. BEATTIE; *Treasurer,* L. L. HARTER. WALTER T. SWINGLE was nominated for *Vice-President* in the Washington Academy of Sciences.

The 131st regular meeting of the Society was held in the Assembly Hall of the Carnegie Institution at 8 p.m., Thursday, December 5, 1918.[1] Forty-four members and three guests were present. The following papers were presented:

Effect of temperature and other meteorological factors on the growth of sorghums: H. N. VINALL. The speaker stated that the purpose of this study was to determine the reactions of the sorghum plant to climatic conditions. Several varieties were grown under field conditions at Chillicothe, Texas, Bard and Chula Vista, California, and Puyallup, Washington. The average of the monthly means of temperature for the growing seasons at the above points was 75.6°, 81.8°, 62.4°, and 60.4° F., respectively. The percentage of actual to possible sunshine was 75, 93, 68, and 46. The total degrees of positive temperature received by the sorghums at Chillicothe was 3028°, at Bard 4236°, at Chula Vista 1895°, and at Puyallup 1615° F.

None of the sorghums matured at Puyallup, but all matured at Chula Vista with only 280° difference in the total of positive temperatures. This would seem to indicate that the amount of sunshine is an important factor in bringing sorghums to maturity. The conformance of the sorghums of Chillicothe, Bard, and Chula Vista to Linsser's Law of Growth was remarkable. The "physiological constant," according to this law, for the period from planting to maturity, was for Chillicothe 0.539, Bard 0.530, and Chula Vista 0.526.

Vegetative characters which are ordinarily considered stable, such as the number of leaves per plant, varied with the climatic conditions. Blackhull kafir had 3 and Sumac sorgo 6 more leaves at Bard than at Chula Vista. The varieties also showed decided differences in height and diameter of the stem and in the size of the leaf at these two places.

Studies on the effects of different dates of planting at Bard indicate that "more favorable conditions are obtained if the date of planting is regulated so that the early stages of the plant's development coincide with a period of high temperatures and the later stages, when the plant is nearing maturity, come when moderate temperatures prevail."

[1] The November meeting was not held on account of the influenza epidemic.

Defects in wood in relation to airplane construction: Lieut. J. S. BOYCE. Since airplane construction aims to secure the maximum strength with the minimum weight, it is self-evident that wood with any defects which weaken it appreciably must not be used for this purpose.

One type of defect is the so-called advance rot, which is merely the early stages of decay, the fungus mycelium having already invaded and weakened the wood, but the only microscopical evidence of this condition is a slight discoloration of the wood. Advance rot is quite prevalent in the more important woods used in airplane construction, among which are Sitka spruce (*Picea sitchensis*), Douglas fir (*Pseudotsuga taxifolia*), yellow birch (*Betula lutea*), white oak (*Quercus alba*), and white ash (*Fraxinus americana*). Considerable skill is necessary to separate stock with advance rot from that with harmless discolorations resulting from chromogenic fungi or other causes.

Very slight lightning wounds, known as "lightning rings," are serious defects in airplane members, since there is a decided tendency for the wood to separate easily along the annual rings in which such wounds occur.

In order to make such defects properly understood in their relative importance, it will be necessary to disseminate information in simple form concerning the structure, mechanical properties, and defects of wood throughout the airplane industry.

The 132nd regular meeting of the Society was held in the Assembly Hall of the Carnegie Institution at 8 p.m., Wednesday, January 15, 1919. Thirty members and five guests were present. Mr. CLIFFORD H. FARR, of the Bureau of Plant Industry, was elected to membership. The following papers were presented:

The potash-containing marls of the eastern United States: R. H. TRUE. Greensand marls were first recognized in America in 1768 near Marlboro, New Jersey. After the Revolution their use as fertilizers developed rapidly, marl railroads having been built in the early thirties to haul marl from the most valuable deposits to the surrounding farming country. In the early forties over a million tons were shipped by rail in one year in this state alone. The digging of similar deposits discovered in Virginia began about 1833 and ceased only when the Civil War broke out. The war and the heavy demand on labor led to the ready adoption of guano, ground bone, and other concentrated fertilizers, and marling practically ceased.

In 1824 Seybert found them to contain calcium carbonate, potassium, and other substances. Rogers and others claimed chief value for potassium, Ruffin for the lime. With the present shortage of potassium these marls furnish a useful source for a very great supply over a practicable hauling radius. Marl samples collected in New Jersey and in Virginia when used in sand cultures yield sufficient available potassium to support a normal growth when supplied at the rate of five or more tons per acre.

Germination of immature seeds: J. B. S. NORTON. The consideration of immature seed harvested under certain conditions in the case of

some crops and at all times with other crops leads to a number of practical questions. It was shown in the experiments reported that wheat seed first began to germinate six days after blossom. Germination increased to 78 per cent at the end of two weeks, then decreased at ripening time and rose slowly to 92 per cent a month after harvest. Corn began to germinate when 12 days old, germinated over 20 per cent in the roasting-ear stage, 88 per cent at four-weeks age, then declined and rose slowly after the grain began to lose weight. Tomatoes, peas, and cowpeas germinated well before maturity, and a number of other species germinated to some extent. Blackberry, lily, euphorbia, and ragweed, seeds that might be expected to have difficult germination when ripe, were tried in immature condition to see if the cause of dormancy acted before ripening. No germination was obtained in these species.

The 133rd regular meeting of the Society was held at the Cosmos Club at 8 p.m., Tuesday, February 4, 1919. Fifty-eight members and five guests were present. Messrs. M. N. POPE, CURTIS H. KYLE, J. P. BENSON, J. I. LAURITZEN, R. N. JONES, P. G. RUSSELL, L. G. HOOVER, and J. A. STEVENSON were elected to membership. The program consisted of the following papers:

Producing self-fertile muscadine grapes (with lantern): CHAS. T. DEARING. The office of Horticultural and Pomological Investigations of the U. S. Department of Agriculture has conducted muscadine-grape investigations for the past 12 years with a view to the development of this native type of grape as a fruit industry for the southeastern United States where other grapes do not thrive. These investigations have been in the nature of field surveys, studies of proper cultural, handling, and utilization methods, and breeding.

The breeding work has aimed toward maintaining the desirable characters of the species while securing improvement in those ways in which this seemed possible. The production of self-fertile varieties has undoubtedly been the most important result. At the time these investigations were undertaken, there was not such a thing as a self-fertile muscadine grape. All the fruiting varieties were self-sterile and dependent on insects to bring fertile pollen from the wild male muscadines. The Department now has a large collection of self-fertile varieties.

The value of these self-fertile varieties is evident. (1) They are of inestimably great value in breeding work in that they afford for the first time the opportunity to intercross within the species without using as one parent a variety of unknown fruiting qualities (male vine). Breeding directly for a combination of the desirable characters found in the fruiting varieties of *V. rotundifolia* is now possible. (2) They afford directly a cluster of increased size (a breeding object) in that the self-fertile varieties are the result of perfecting the large-clustered male-type blossoms rather than the small-clustered female-type blossoms. (3) They afford greater productiveness in that they are able to set a larger per cent of the bloom buds as berries due to their self-fertility.

They afford opportunities for greater vineyard production as well as vine production, for they can be used in place of nonproductive male vines as pollinators for imperfect hermaphrodites.

It has been abundantly proved that the new perfect-flowered or hermaphroditic type is a result of perfecting the pistils of the bloom of the male type of vine rather than the rudimentary stamens of the bloom of the female type. It is believed that it is merely a matter of time until only perfect-flowered, self-fertile muscadine grapes will be grown in the vineyards of the South.

Plant responses under artificial light (with lantern): L. C. CORBETT. That light is one of the most important factors in the environment of green plants has been recognized as long as any phenomenon of plant physiology has been observed. Many experiments have been conducted to demonstrate the effects of the presence or absence of light as a factor of environment. The great majority of these experiments are merely qualitative. They demonstrate the effect of a force with no attempt to analyze or measure it. Plant physiology has up to recent time been largely a qualitative science. This is to be explained chiefly on the ground that bio-chemistry has not been sufficiently developed to permit plant physiology to be other than a qualitative science. While, as has been stated, there are numerous simple tests to illustrate the fact that light directly influences various plant activities, few studies have been undertaken to show the relation of various portions of the spectrum to plant responses.

More than twenty years ago the speaker had an opportunity to conduct a series of tests to determine the influence which artificial light, used as a supplement to daylight, might have on the rate of development of various plants growing in greenhouses. After a series of tests extending over three years to determine the influence of incandescent gas light as a supplement to daylight, a series of tests was inaugurated to determine the influence of various-colored incandescent gas lights on plant growth, when used as a supplement to daylight. In these tests incandescent gas lamps were provided with globes tinted red, blue, and green. The behavior of plants in the field of such lights was compared with the behavior of like plants in the field of lamps carrying clear globes. Different plants gave varying responses under the stimulus of the different-colored light, but each light induced a characteristic effect which was consistent for all plants, but in varying degrees.

CHAS. E. CHAMBLISS, *Recording Secretary.*

ENTOMOLOGICAL SOCIETY OF WASHINGTON

The 319th regular meeting of the Society was held Feb. 6, 1919, in the new Assembly Hall of the Cosmos Club; 36 members and 10 visitors were present.

The following new members were elected: Dr. U. C. LOFTIN, of the Bureau of Entomology, JOHN D. SHERMAN, of New York, and E. A.

McMahon, of the Entomological Laboratory at Annapolis Royal, Nova Scotia.

The regular program was as follows:

W. M. Mann: *Notes on the Solomon Islands.* An account of a collecting trip to these islands, illustrated by lantern slides showing the topography, flora, fauna, and the various types of natives, their dress, habits, implements, and customs.

N. E. McIndoo: *The olfactory sense of lepidopterous larvae.* The author described experiments conducted to determine if the larvae are able to distinguish between various plants offered them as food, the result of these experiments proving that they are able to do so. The author is of the opinion that this is accomplished by means of an olfactory sense and locates the seat of this sense in certain minute pits scattered over various portions of the body, each pit connected with a sense cell. The structure and position of these organs were illustrated by charts and drawings.

In discussing this paper Mr. Busck congratulated Dr. McIndoo on his work and commented on the far-reaching possibilities it suggested in economic entomology, when we shall know enough about these supposed olfactory organs to tempt the codling moth away from the apple by a perfumed bait. He pointed out that the organs described by Dr. McIndoo were by no means a new discovery, but that at least those of the head were well known by lepidopterists and had all been carefully mapped out and named in connection with the parts of the head and the head setae. Their position relative to the setae is constant for each species and yields excellent generic and family characters, which enable determination merely from a larval head capsule.

Mr. Busck stated that he had hitherto considered the punctures as remnants of aborted setae and he still thought they must be considered such, modified to serve other senses than touch; the setae are sense-touch organs and have nerves running to their bases like the punctures. As one ground for this view he mentioned that certain of these supposed olfactory punctures, the ultra posterior punctures on the head, in some species bear a small hair and in others not.

Mr. Busck criticized and objected to Dr. McIndoo's arbitrary numbering of these punctures, starting on the thorax, continuing to the last abdominal segment, and ending with the head. He suggested as more rational and simpler to name them after the part of the body they are found on, and he thought it common sense to adopt the already existing names for the head punctures, which were used by Heinrich and himself and which were named after the head parts on which the punctures are situated.

Dr. Pierce emphasized the bearing that papers like that under discussion have on taxonomy and economic entomology, and predicted that in future the determination of larvae by the minute characters of small fragments will be very generally possible.

In reply to a question, Dr. McIndoo stated that the organs that he had discussed are, in his opinion, used by the insect in selecting its host, but that this is theoretical. Dr. BAKER stated that similar organs in aphids undergo modification when the insects change to another host plant for a long series of generations, and that in some cases it is possible to determine from this what host plant a given individual developed on. Mr. Busck was of the opinion that the lepidoptera are not so susceptible to changes in host.

Notes and exhibition of specimens: Mr. CAUDELL exhibited a specimen of the Dectician *Capnobotes fuliginosus* Thomas that had fallen prey to the wasp *Palmodes praestans* Kohl, the interesting points being that the prey, itself probably predaceous, was killed by a wasp very much smaller than itself and that the wasp is the fourth known specimen of its species.

Mr. WOOD commented on the fact that living individuals of the woolly apple aphis are now present in aerial colonies and attributed this to the mild winter.

R. A. CUSHMAN, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The Division of Mineral Resources of the U. S. Geological Survey has been reorganized, with Dr. Edson S. Bastin as geologist in charge. The section of metals will be in charge of G. F. Loughlin; the section of nonmetals, other than fuels, R. W. Stone; the section of mineral fuels, C. E. Lesher; and the section of foreign resources, J. B. Umpleby. Mr. H. D. McCaskey, formerly chief of the Division, asked to be relieved of his administrative duties after the signing of the armistice in November, and will devote his time to special phases of American mineral resources.

Dr. Samuel S. Adams has been elected vice-president of the faculty of Georgetown University, to fill the vacancy caused by the death of Dr. Frank Baker.

Mr. A. D. Conley, associate physicist in the paper and textile laboratory of the Bureau of Standards, resigned from the Bureau in February to take up special research for the Wm. E. Cooper Company, of Baltimore, Maryland.

Miss Aida M. Doyle resigned from the Bureau of Chemistry in February and is now with E. I. du Pont de Nemours & Company, of Wilmington, Delaware.

Mr. J. D. Edwards, associate chemist, and Mr. A. D. Bell, assistant chemist, Bureau of Standards, expect to leave the Bureau in April to take up research at the laboratory recently organized by Dr. F. C. Frary for the Aluminum Company of America, at Pittsburgh, Pennsylvania.

Dr. F. C. Frary, formerly of the Oldbury Chemical Company of Niagara Falls, who has lately been engaged in war research, first in Washington and later at the Edgewood Arsenal of the Chemical Warfare Service, is organizing a research laboratory for the Aluminum Company of America, at Pittsburgh, Pennsylvania.

Dr. Aleš Hrdlička, Curator of Physical Anthropology in the U. S. National Museum, has been elected a member of the American Philosophical Society.

Mr. W. H. Keen, formerly general manager of the Chemical Products Company and metallurgical superintendent of the Washington Steel and Ordnance Company, is now factory manager of the U. S. Copper Products Corporation, of Cleveland, Ohio.

Dr. Willis T. Lee is on leave of absence from the Geological Survey, and is now head of the Department of Geology and Director of the School of Engineering Geology in the University of Oklahoma, at Norman, Oklahoma.

Major J. H. Mathews, who has been with the Ordnance Department in Washington, has returned to the University of Wisconsin as professor of physical chemistry.

Prof. Earle B. Phelps, Professor of Chemistry at the Hygienic Laboratory, Public Health Service, resigned from the Service on March 1, 1919.

Professor Edward Charles Pickering, professor of astronomy and director of the Harvard College Observatory, and a nonresident member of the Academy, died at Cambridge on February 3, 1919, in his seventy-third year. Professor Pickering was born at Boston, Massachusetts, July 19, 1846. Excepting the years 1867–1876, during which he was Thayer Professor of Physics at the Massachusetts Institute of Technology, his entire academic career was spent at Harvard University. His astronomical work was especially concerned with the photometry and spectrum photography of the light of the stars. He was a member of the National Academy of Sciences, president of the Astronomical and Astrophysical Society of America, and a member of many American and foreign societies and academies. He had been a member of the Academy since 1899, and was one of its nonresident vice-presidents in 1915 and 1916.

Mr. Richard L. Templin, formerly of the Bureau of Standards, is Engineer of Tests for the Aluminum Company of America, at New Kensington, Pennsylvania.

Mr. Carl Vrooman, Assistant Secretary of Agriculture, resigned in January. Mr. Vrooman will remain for the present in Europe, where he had gone as a member of the Agricultural Commission sent out by the Department.

Mr. F. A. Wertz, associate chemist at the Bureau of Standards, will leave the Bureau in March to take up research on varnishes and allied products for the Devoe and Raynolds Company, Incorporated, of New York City.

Brigadier General John Moulder Wilson, U. S. A., retired, died at his home, 1773 Massachusetts Avenue, on February 1, 1919, at the age of 81. General Wilson first came to Washington in 1885, as superintendent of buildings and grounds, in which capacity he had charge of the construction or completion of many of the now familiar structures of the city. He became Chief of Engineers in 1897, and retired in 1903. He had been for the past fifteen years a member of the Board of Managers of the National Geographic Society.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 9 MARCH 19, 1919 No. 6

CRYSTALLOGRAPHY.—*The classification of mimetic crystals.*
EDGAR T. WHERRY and ELLIOT Q. ADAMS, Bureau of Chemistry.[1]

As more or less fully described in all text-books on crystallography, crystals which belong fundamentally to one system or symmetry class may at times exhibit features characteristic of other systems or classes. This may result from accidents of growth, or from the approach of the angles to those of other systems, either with or without twinning. It is customary to group together part or all of these phenomena under the general head of mimicry, mimetism, or mimetic behavior, and to add the prefix *pseudo-* to the name of the system or class to which the crystals apparently belong. In discussing certain crystallographic relationships, however, it may become desirable to distinguish the several types of mimetic phenomena on the basis of their underlying causes, and to have special terms, for both the original system or class and the one imitated, to apply in each case.

The principal types of mimetic behavior are presented in table 1, together with prefixes proposed for, and typical illustrations of, each of them. The prefixes are derived from well-known Greek roots, transliterated in accordance with accepted usage. The illustrations are drawn from minerals, since the features in question are most familiar in them, although the greatest use for the classification may prove to be among artificial

[1] Contribution from the Crystallography and Color Laboratories.

compounds. The subdivisions are, it should be noted, not mutually exclusive, and one crystal may fall simultaneously into two or more of them, although usually most typical of one.

The names of the crystal systems and classes used are drawn largely from Dana, with the following exceptions: cubic in place of isometric; trigonal as a distinct system; and rhombic in place of orthorhombic. No changes in the plans of nomenclature here proposed will need to be made should the use of other names be preferred.

TABLE 1.

TYPES OF MIMETIC PHENOMENA, WITH PREFIXES PROPOSED, AND ILLUSTRATIONS

General prefixes for the whole group: for original class, *homo-* (same); for class imitated, *pseudo-* (false)

Cause	Extrinsic; peculiarities of habit	Intrinsic; angles approaching those of other classes: Crystals twinned	Intrinsic; angles approaching those of other classes: Crystals simple
Resulting change an apparent increase in symmetry			
Prefix for original class	*crypto-* (hidden)	*ana-* (upwards)	*lepto-* (slight)
Prefix for class imitated	*pheno-* (apparent)	*syn-* (together)	*peri-* (around)
Illustration	quartz, crypto-trigonal but pheno-hexagonal	aragonite, ana-rhombic but syn-hexagonal	albite, leptotriclinic, but peri-monoclinic
Resulting change an apparent decrease in symmetry			
Prefix for original class	*endo-* (within)	*kata-* (downwards)	....
Prefix for class imitated	*ecto-* (without)	*para* (beside)	....
Illustration	copper, endo-cubic but ecto-trigonal	spinel, kata-cubic but para-trigonal	....

DISCUSSION OF TABLE 1

Whenever it is desired to refer to mimetic behavior without considering the cause or effect as such, the prefixes *homo-* and *pseudo-*, signifying, respectively, "the same" and "false," may be used. For instance, the crystallization of the aragonite group may be described as "homo-rhombic but pseudo-hexagonal."

The cause of mimetic phenomena may be, first, extrinsic, or connected with influences outside of the crystal, leading to peculiarities of habit which may constitute either apparent increase or apparent decrease in symmetry. It not infrequently happens that the only forms present on a crystal possessing a low degree of symmetry may be those which the class represented has in common with other more symmetrical classes. A good example of this is quartz, which though actually trigonal and trapezohedral, may show only the first order prism and the corresponding plus and minus rhombohedrons. If perfectly developed, the only symmetry which this combination can show is holohedral-hexagonal. It is here suggested that the true class of a substance showing such a relationship be indicated by the prefix *crypto-*, meaning "hidden," and the class which is apparently represented by *pheno-*, signifying "apparent." The quartz crystals showing only hexagonal forms would then be fully described by stating them to be: "crypto-trigonal-trapezohedral but pheno-hexagonal-holohedral." Other illustrations are pyrite, which is often crypto-pyritohedral but pheno-holohedral cubic; apatite, which is usually crypto-pyramidal but pheno-holohedral hexagonal; and so on.

A still more frequent type of mimetic effect, though not always classed as such, is the decrease in apparent symmetry due to distortion or irregularity in habit produced by external influences. This effect is, indeed, almost universally present among crystals, really perfect development being practically never met with. Whenever simple descriptive terms are needed for this type of relationship, the prefixes *endo-*, meaning "inside," and *ecto-*, "outside," may be used. To cite a familiar example, the metal copper, though well known to be fundamentally cubic, or endo-cubic, is almost always distorted, and may be ecto-trigonal, ecto-rhombic, or even ecto-triclinic.

The second class of causes of mimetic phenomena may be termed intrinsic, since essential features of the internal structure of the crystal are responsible. The effect is connected with the approach of the angles in crystals of one system or class to those of another, and develops most commonly through more or less

multiple twinning. The symmetry is usually increased by such twinning, hence good descriptive prefixes are *ana-*, meaning "upwards" and *syn-*, "together." The common twinned crystals of aragonite, for instance, would then be termed: "ana-rhombic but syn-hexagonal;" phillipsite, "ana-monoclinic but syn-tetragonal;" boracite, "ana-rhombic but syn-cubic," and so on. Less frequently the symmetry is decreased by twinning, whereupon the original class may be designated by *kata-*, meaning "downwards" while *para-* "beside" referring to the individual parts of the twins, may be used for the imitated one. Thus spinel and other cubic minerals, when twinned on the octahedron, often become apparently trigonal; they may be described as "kata-cubic but para-trigonal."

There is still another situation in which the crystals of one system may imitate those of another, consisting in the mere approach in angular values without twinning or distortion. It should be noted here that the prefix *hypo-* has been applied rather extensively to this type of relationship, though it is not limited to mimetic crystals, but is used broadly for approach of angular values to within $15°$ of those of the cubic, tetragonal, or hexagonal systems. A new term is therefore needed for the purpose of the present classification. The prefixes suggested to describe this type of relationship are *lepto-*, which means slight, and *peri-*, which means around or about. For instance, the triclinic plagioclase feldspars, such as albite, approach the monoclinic orthoclase very closely in angles and habit. The deviation of their interaxial angles α and γ from $90°$, the value characteristic of the monoclinic system, is but slight, and this can be well expressed by calling them "lepto-triclinic but peri-monoclinic," that is, "weakly triclinic, and approaching monoclinic angular relationships." Other well-known examples are chalcocite, which is lepto-rhombic and peri-hexagonal; muscovite, lepto-monoclinic and peri-hexagonal; and chondrodite, lepto-monoclinic and peri-rhombic.

In conclusion it may be noted that the purpose of this paper is not primarily the development of terms for these types of mimetic phenomena, but rather the pointing out that it may at

times be useful to distinguish the different types. Even though none of the prefixes proposed be thought worthy of general adoption by crystallographers, it is hoped that the desirability of some method of distinction of the several types will not be forgotten, and that in future descriptions of mimetic crystals it will rarely be considered sufficient to refer to them only by the prefix "*pseudo*."

BOTANY.—*Synopsis of the genus Ochroma, with descriptions of new species.* W. W. ROWLEE, Cornell University. (Communicated by Frederick V. Coville.)

The utilization of the wood of *Ochroma* has brought that genus into prominence during the last few years. The manufacture of buoyancy and insulation products, such as life rafts, refrigerators, and parts of lifeboats and aeroplanes, especially in connection with the war, has become very extensive. Eighty thousand floats made of balsa wood were used in constructing the 250-mile submarine mine barrage in the North Sea; war vessels as well as transports were in so far as possible equipped with balsa life rafts and lifeboats; and special refrigerating trucks with balsa as the insulating material were used in France. The characteristics of the wood were investigated by the late Professor R. C. Carpenter in a very thorough manner and the results were published in a paper entitled *The properties of balsa wood.*[1] The importance of obtaining first-hand information regarding the quantity of wood available, and of discriminating between the usable and unusable wood, led the American Balsa Corporation to commission the writer and his son in April, 1918, to explore Central America with a view to finding out the amount of timber available and to investigate as to the quality of the wood and the kinds that grow in different regions. For this purpose we spent seven months in Panama, Costa Rica, Nicaragua, and Guatemala. The taxonomic results of the survey are given briefly in this paper.

The wood of the trees of the genus *Ochroma* is the most notable among lightweight woods. It is generally known in Spanish

[1] Trans. Amer. Soc. Civ. Eng. 81: 125. 1917.

America as "balsa," and that word has been transferred to and is in general use in the United States. Balsa is the Spanish word for raft, and it was applied to this tree because the Spanish colonists, when they migrated to the New World, found it in use by the natives for rafts. When they found a tree obviously related to an Old World species, the colonists usually transferred the European name to the new tree. Thus, "roble," the Spanish name for oak, was applied to like trees in the New World; but there was nothing in Spain in any way like balsa, and so the name of the object for which this wood was used was transferred to the tree itself. This name was and still is largely confined to countries where the trees were so used, that is, Ecuador, Colombia, and Costa Rica. In Nicaragua the tree is called "gatillo;" in Guatemala, "cajeto" on the west coast, and "moho" and "lana" on the east coast; in Cuba, "lanillo;" in Jamaica "corkwood" and "down tree," or as the Jamaican negroes have it, simply "dum." In these regions it is doubtful if it was ever used for rafts.

Balsa is a very common and conspicuous tree in tropical America. It is distinguished not only by its light soft wood, but also by its large simple leaves, large solitary flowers, and very conspicuous fruit, which is not unlike a cotton boll on a large scale. When the fruit is matured, but has not finally burst, it looks much like a rabbit's foot and presumably from this the first species of *Ochroma* to be described received the specific name "*lagopus*." When the fruit finally bursts and the mass of down falls to the earth, it suggests the fur of a rabbit. The seeds are enveloped in this fur and are disseminated by it. They resemble small grape seeds and, unlike cotton, the "down" is not firmly and permanently attached to the seed.

The tree of the Greater Antilles was first given a binary name, *Ochroma lagopus*, by the Swedish botanist, Olaf Swartz, in 1788[1] and was more fully described by him four years later.[2]

At about the same time Humboldt collected specimens of another species in the upper valley of the Magdalena River in

[1] Prodr. Veg. Ind. Occ. 98. 1788

[2] Act. Stockh. 148 *pl. 6.* 1792 See also Swartz's later description, Fl. Ind. Occ. 2: 1143. 1800.

Colombia and this was described by Willdenow under the name *Ochroma tomentosa*. This second species has never been found outside the region where Humboldt collected it. Swartz's type locality is "Jamaica, Hispaniola," but specimens from South America, Central America, and the West Indies have been universally referred to *O. lagopus*. These two species are the only ones recognized in botanical literature at the present time.

Ochroma is confined to tropical America. Its nearest relative in the eastern hemisphere is the baobab tree. It is a relative of the "ceiba" (*Bombax*) and "quipo" (*Cavanillesia*), of tropical America.

The species of this genus most frequently occur in the lowlands and foothills, though rarely, if ever, where the soil is at all affected by brackish or salt water. They have not been discovered in the higher altitudes, that is, at more than 1,000 meters above sea level.

Balsa is usually a second-growth tree, though it does occur as an isolated tree in the primeval forest. It appears promptly and abundantly where clearings have been made by natural agencies, such as floods and fires, or by human cultivations. In this respect it might properly be called a tree "weed." The natural seeding in some places produces such an abundance of young plants as to suggest weeds in a neglected garden. The tree's growth is very rapid. During the first five or six years of its life it may attain a trunk diameter of 60 to 75 cm., an average increase in thickness of 12 or 13 cm. per year. It also grows very rapidly in height, often attaining under favorable conditions 16 or 20 meters in five or six years. This gives it a place among the most rapidly growing trees known, if indeed it is not the most rapid of all.

In the natural state, the wood is very perishable. One rarely sees the remains of trees of balsa in the tropical forests. They decay with apparently the same rapidity as a cotton fabric; the wood absorbs moisture readily and shrinks and warps badly. This is due undoubtedly to the feeble lignification of the cell walls and to the lack of aseptic properties such as the timber of oak and pine possess. It was only when the engineers of the

American Balsa Company, after protracted investigation and experiments, overcame these defects that the wood could be fabricated into valuable products.

The leaves of *Ochroma*, even on an individual tree, are variable. The seedlings of the different species are much more difficult to distinguish, one from the other, than are the mature trees. Even in the case of two species so distinct as *O. concolor* and *O. limonensis* the seedlings are very much alike. We have based our descriptions upon the leaves of mature trees. The flowers, however, are characteristic for each of the several species, though they vary in shape, size, and texture.

TABLE 1.

APPROXIMATE TIME OF FLOWERING AND FRUITING OF OCHROMA

	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.
concolor	....	....	Fl.	Fl.	Fr.	Fr.	....	....	....	....	....	....
lagopus	....	....	....	Fl.	Fl.	Fr.	Fr.	....	....	....	....	....
limonensis	....	....	....	....	....	....	Fl.	Fl.	Fr.	Fr.	....	....
grandiflora	....	....	....	....	....	....	....	....	Fl.	Fl.	Fr.	Fr.
tomentosa	....	....	Fl.?	....	....	....	....	Fl.	Fl.	Fr.	Fr.	....
velutina	....	Fl.	Fl.	Fr.	Fr.	....	....	....	....	....	....	....
bicolor	Fl.	Fl.	Fr.	Fr.	....	....	....	....	....	....	....	....
boliviana	....	....	....	....	....	....	....	Fl.	Fl.	Fr.	Fr.	....
obtusa	....	....	Fl.	Fl.	Fr.	Fr.	....	....	....	....	....	....

The species of *Ochroma* differentiate into two classes as regards time of flowering and fruiting. In one group the fructification takes place in the months of November and April; in the other flowers and fruits develop from May to October.

Table 1 is based on our observations in Central America, supplemented by an examination of herbarium specimens and notes by collectors. Five of the species bear flowers and fruit in one season of the year and four in the other season. So far as we could learn, the season of flowering is clearly marked. For example, no flowers or fruit were to be found on the Limón balsa (*O. limonensis*) from December to March, while both were present in profusion from May to August. On the other hand no flowers or fruit were to be found on the Guapiles balsa (*O. bicolor*) from May to August, but an abundance occurs from

November to February. These species grow in contiguous regions and, though they may overlap somewhat in distribution, they are nevertheless distinguished by well marked morphological characters.

With the exception of *O. limonensis* all these species flower and fruit in the dry season of their respective regions. In northeastern Costa Rica there is no well defined dry season and this probably accounts for the exceptional flowering period of *O. limonensis*.

KEY TO SPECIES

Calyx lobes carinate. Outer sepals triangular acuminate.
  Leaves thin, green on both sides, conspicuously 5 to 7-lobed, glabrous or nearly so .... 1. *O. concolor.*
  Leaves thick, rusty-pubescent, at least beneath, obsoletely 3 to 5-lobed.
    Flowers 10 cm. long .... 2. *O. lagopus.*
    Flowers 15 cm. long or more.
      Calyx tube cylindric .... 3. *O. limonensis.*
      Calyx tube widened upward .... 4. *O. grandiflora.*
Calyx lobes not carinate.
  Leaves repand-dentate .... 5. *O. tomentosa.*
  Leaves not repand-dentate.
    Calyx lobes triangular, acute, coriaceous.
      Leaves rusty-tomentose on both sides, the hairs 5 to 7-(mostly 6)branched .... 6. *O. velutina.*
      Leaves glabrous and dark green above, white and stellate-pubescent beneath, the hairs 10 to 15-(mostly 12)branched.
        7. *O. bicolor.*
    Calyx lobes elliptic or orbicular, obtuse, herbaceous.
      Calyx lobes elliptic; leaves densely velutinous beneath.
        8. *O. boliviana.*
      Calyx lobes orbicular; leaves scantily pubescent beneath.
        9. *O. obtusa.*

1. **Ochroma concolor,** n. sp. BARRIOS BALSA.

A tree attaining 25 meters in height and 1 meter in diameter, in woodlands developing a long, smooth trunk, in the open a short trunk and a round, symmetrical top; heartwood in older trees red, wet, and heavy, the wood of young trees white and light; leaves thin and membranous, large and conspicuously lobed, with 5 to 7 acute lobes separated by broad, convex sinuses, green and glabrous on both sides except for a few tufts of brownish tomentum on the primary veins beneath; stipules large, ovate, with prominent midribs; flowers 10 cm. long, glabrous; calyx tube 6 cm. long, glabrous within; calyx lobes very dissimilar, 2 cm. long, the outer 2 acuminate, with a prominent

keel on the back, the inner 3 oblong, keeled, with expanded margin; pod 12 cm. long; seed with a short, stout funicle.

Type in the U. S. National Herbarium, no. 862345, collected at Trece Aguas, Alta Verapaz, Guatemala, May 9, 1914, by O. F. Cook and C. B. Doyle (no. 82). The following Guatemalan specimens in the National Herbarium also represent this species: *Mrs. William Owen* 11, 11A; *Goll* 230. The flowers are borne in December and January and the fruit in February and March.

This species is very different from any other of the genus. It is known only from the country surrounding the head of the Bay of Honduras. It has not been reported from outside of Guatemala, but undoubtedly grows in adjacent Honduras and British Honduras, and in all probability in southern Yucatán. It occurs throughout the lower Motagua Valley from above Quirigua to the sea. Well developed trees are found on the reservation containing the Maya ruins, near Quirigua. It also occurs rather abundantly in the valley of Lake Izabal and the Golfete.

Goll reports the name "kapok;" Mrs. Owen gives the Indian names "jujul" and "puj." The local names given us were "lana" and "cajeto."

There are two distinct species of *Ochroma* in northeastern Guatemala. In addition to the one characterized above, there is another which is probably specifically identical with the species of northern Costa Rica. *Ochroma concolor* grows on lower ground than the Costa Rican species or, indeed, than any other species of *Ochroma* known to us. In the Great Swamp, along the San Francisco del Mar River, east of Barrios and west of the mouth of the Motagua, many large trees occur on ground that is inundated a considerable portion of the year. The species occurs also on higher ground, as on the hospital grounds at Quirigua, as well as near Virginia and along the Tomeja River.

2. **Ochroma lagopus** Swartz, Prodr. Veg. Ind. Occ. 98. 1788.

WEST INDIAN BALSA.

Up to the present time, all the species of the genus except *Ochroma tomentosa* Willd. have been included under this name, which, there is every reason to believe, should be restricted to include only forms that grow in the West Indies.

Smaller in size than the preceding species, usually not exceeding 30 cm. in diameter and 18 meters in height; leaf blades small (15 to 20 cm.), brown-tomentose to nearly glabrous; flowers small, 10 cm. long; calyx tube 6 cm. long, the lobes 2.5 cm. long, 2 cm. wide at the base and 4.5 cm. at the summit, prominently carinate on the back.—Flowers borne in February and March; fruit in April and May.

Known in Cuba as "lanero;" in Jamaica as "corkwood," "down-tree," "dum," and "bombast mahoe."

CUBA: Eastern Cuba, 1856–57, *C. Wright* 38; San Luis, Oriente, April 2, 1909, *Britton* 2334; Sevilla Estate near Santiago, August 31, 1906, *N. Taylor* 140 (a tree 30 meters high, the trunk 28 cm. in diameter).

HISPANIOLA: Taradia, prope Barahona, 1910, *Tuerckheim* 2826; without locality, *Wright, Parry & Brummel* 20, 21.

PORTO RICO: Manati, April 4, 1887, *Sintenis* 6766; Utuado, March, 1906, *M. A. Howe;* San Juan, December, 1898, *Dignowitz* 780.

JAMAICA: Castleton, March 21, 1915, *Harris* 11962.

3. **Ochroma limonensis,** n. sp. LIMÓN BALSA.

A tree of very rapid growth, attaining large dimensions, up to a meter in diameter and 30 meters in height; bark gray, somewhat mottled; wood white, the annual rings indistinguishable; leaves large, nearly orbicular, 25 cm. across, obsoletely 3- to 5-lobed (the margin entire), nearly or quite glabrous above, refescent-tomentose beneath; hairs 7 to 10-(mostly 8)branched; flowers 18 cm. long, yellowish white; calyx tube 9 cm. long, cylindric, glabrous but warty on the outside, hairy within; calyx lobes acuminate, carinate on the back, 4 cm. long, 2 cm. wide at the base, the inner with feltlike margins; pods, 15 cm. long; funicle about half as long as the seed.—Flowers borne in May and June; fruit in July and August.

This is the balsa of the lowlands of the Caribbean coast of Costa Rica and Panama, extending as far west as the Reventazón River, Costa Rica, and east into Panama. Fine groves have developed along the Banana, Bananito, Estrella, and Sixaola Rivers. Our nos. 1, 2, and 3 are of this species, no. 1, collected on San Clemente Farm east of the Bananito River, Costa Rica, being the type. No. 2 is from a tree at Zent; no. 3 was collected near Moin Junction. The Zent tree is of special interest. It was started as a seedling in April, 1915, and was photographed September 15th of that year. When measured by us in May, 1918, it was 16 inches in diameter, and had therefore grown at the rate of five inches per year. Local observers agree that this individual is not in any way exceptional.

4. **Ochroma grandiflora,** n. sp. ECUADOR BALSA.

A tall tree with mottled gray bark and very light wood; leaves on mature trees nearly entire, orbicular, 20 cm. wide, on young trees lobed, very large (up to 90 cm.), rufescent beneath, glabrous above; flowers 15 to 18 cm. long, showy; calyx tube 7 cm. long, spreading above, 3 cm. wide at the base, 7 cm. wide at the top, granular-puberulent outside, hairy within; calyx lobes 4 cm. long, 3 cm. wide at the base, carinate, the inner ones broadly margined; petals large and showy, exceeding the stamens and style, the limb 5 cm. broad, gradually

narrowing into a broad claw 2 cm. wide, prominently parallel-veined.—Flowering in July and August; fruiting in September and October.

Type in the U. S. National Herbarium, collected below Huigra, Ecuador, in 1918, by J. N. Rose (no. 22,604). Also collected at Hacienda La Josefina, San Carlos, Ecuador, September, 1918, by Capt. Claussen.

5. **Ochroma tomentosa** Willd. Enum. Hort. Berol. 695. 1809

HUMBOLDT'S BALSA.

The original description of this species is as follows: "O. foliis cordatis subtrilobis repandis, subtus tomentosis." It was based on specimens collected by Humboldt and Bonpland in "America Meridionali," and was reported from Colombia by Triana and Planchon in 1862.[1] It has been collected recently by Rusby and Pennell (no. 271), July 24, 1917, at Quebrada de Angeles, above Natagaina, Department of Huila, Colombia, and also by Pennell (no. 3557), at Honda, Department of Tolima, Colombia. The collectors noted it as a large tree with white petals.

The calyx tube is very coarsely and densely tomentose with brown hairs; the tube is short and broad. Most characteristic of the species, however, are the repand dentations, 1 cm. apart, evenly distributed around the margin of the leaf, giving it the appearance of the leaf of *Populus grandidentata*.

Ochroma tomentosa has not been reported beyond the limits of the upper Magdalena River in Colombia, a region through which Humboldt's expedition passed.

6. **Ochroma velutina**, n. sp. RED PACIFIC COAST BALSA.

Wide-spreading tree, usually bifurcately branched, with smooth, light gray bark; heartwood reddish; young shoots and leaves densely velvety-tomentose; leaves ovate, with wide sinuses at the base, obsoletely 3-lobed, or more often entire, the lobes when present rounded; blades variable in size, thick and firm, longer than broad; stipules brownish tomentose, 1 to 1.5 cm. long and half as wide, when large inclined to be auriculate and notched at the side, when small, oblong and rounded at the apex; flowers small, about 8 cm. long, the pedicels of about the same length, calyx tube firm and woody, cylindric, 4 cm. long, glabrous externally at maturity, within densely clothed with ascending appressed brown hairs, calyx lobes very dissimilar, the 2 outer triangular, 1.5 cm. long, the inner 2.5 cm. long, with wide felt-like margins; petals about 8 cm. long, broadened toward the apex; pod 10 to 15 cm. long, tapering at the ends.

Type in the U. S. National Herbarium, no. 472290, collected "dans les forêts et pâturages de Nicoya," Costa Rica, February, 1900, by

[1] Ann. Sci. Nat. IV. Bot. 17: 323. 1862.

A. Tonduz (no. 13,498). The following additional specimens have been seen: El Salvador, *Renson* 86; Bismarck, Panama, *Williams* 607, Ancón Hill, Panama, *Bro. Celestine* 119. The following are our own collections: Orotina, 94; Zapotal, 6; Abangarez Pueblo, 5; Tempisque, 113, 170, 189; all from Costa Rica. We collected it also at Escuintla, Guatemala.

The flowers are borne in December, January, and February. The fruit matures in February, March, and April, that is, the dry season of the region where the tree occurs.

This is the smallest-flowered species known. It is widely distributed on the Pacific slope of Central America from sea-level up to 500 or 600 meters and may be the form mentioned by Tonduz as "caractéristique pour la zone inférieur côtes nord et ouest de Cocos Island, alt. 0–100 m."

Ochroma velutina differs from the other species in the following respects: Its wood is harder and heavier; the leaves are densely velutinous on both sides, are nearly or more often quite entire, and are noticeably longer than broad, with a wide sinus at the base; the flowers are small; and the calyx tube is cylindric, firm, and woody.

7. **Ochroma bicolor,** n. sp. GUAPILES BALSA.

A tree attaining large size, 25 meters high and 1 meter in diameter, with long, straight bole in the forest, and excurrent in habit when growing in the open; bark mottled gray and white; leaves chalky white with minute stellate hairs beneath, these 12 to 20-(mostly 20)branched, dark, glistening green and glabrous above, thick and leathery, tending to be acuminate, especially on the older trees, nearly as broad as long, about 32 cm. across, with 2 to 4 obsolete primary lobes on each side, the margin between these usually regularly and very shallowly sinuate-lobed, with a vein terminating in each secondary lobe, the marginal vein prominent; flowers with petals strongly reflexed at anthesis, 10 cm. long with petals extended; calyx tube firm, 5.5 to 6 cm. long, granular-puberulent outside, silvery-sericeous within; calyx lobes 1.5 cm. long, plane on the back, triangular, acute, the inner ones with felted margins; petals white, abruptly expanded above, the claw 1 cm. broad, the limb orbicular, 3 cm. in diameter; stamen tube and stigma equal in length, slightly shorter than the extended petals, much exceeding the recurved petals at anthesis; mass of anthers as broad as long; pod, 16 cm. long; down, light-colored; seed with very short or obsolete funicle, 4 mm. long, 2 mm. thick.—Flowering in November and December; fruiting in January, February, and March.

The type is our no. 10, collected on the grounds of the residence of Superintendent J. H. Wilson of the United Fruit Company, at Guapiles, Costa Rica. We also collected this species at Guácimo, along the Parisima River. It is abundant throughout the whole region known

as the Llanuras de Santa Clara, Costa Rica, at a general elevation of about 250 meters. The only specimens we have seen in herbaria are Captain J. D. Smith's no. 6,453, from La Emilia, Costa Rica, collected in April, 1896, and C. F. Baker's no. 2,149, from Chinandega, Nicaragua.

This species is very abundant in northern Costa Rica from the Reventazón River north to Lake Nicaragua. It grows on higher land than the Limón balsa, and while the two species grow in contiguous districts they do not overlap to any great extent. It extends up the Turrialba Volcano to a height of a thousand meters or more, and undoubtedly occurs on the whole northerly slope of the central cordillera of Costa Rica.

When in leaf only, and especially with young trees, this species closely resembles the Limón balsa, but the flowers are markedly different. The pubescence, general outline, and texture of the leaves, as well as the period of flowering, clearly distinguish the two species.

8. **Ochroma boliviana,** n. sp. BOLIVIAN BALSA.

A tree 8 to 10 meters high, the trunk 20 to 25 cm. in diameter, leaves obsoletely 3-lobed (the margin undulate but not denticulate), nearly orbicular, 30 cm. in diameter, glabrous and dark green above, tawny white and densely velvety beneath; calyx tube 5.5 cm. long, granular-puberulent outside and densely white-tomentose within; calyx lobes herbaceous-membranous, elliptic, acute, 4 cm. long, 2 cm. wide, the inner ones not sharply differentiated into margin and keel, stellate-pubescent without, densely white-tomentose within; petals conspicuously parallel-veined and expanded above, protruding 5 cm. beyond the calyx lobes, 5 cm. broad above.

Evidently very showy in flower, suggesting the northern tulip tree. Flowers borne in July and August; fruit in August and September.

Known only from the following specimens, in the herbarium of the New York Botanical Garden, all from the northeastern part of Bolivia in the vicinity of Mapiri: Mapiri, July–August, 1892, *Bang* 1501 (type); junction of the rivers Beni and Madre de Dios, August, 1886, *Rusby* 1927; Mapiri, September 23, 1901, *Williams* 714; "San Carlos region de Mapiri, 15° lat. sur," September, 1907, *Buchtien*. Vernacular names "tami" and "palo de balsa."

9. **Ochroma obtusa,** n. sp. SANTA MARTA BALSA.

A tree 10 to 15 meters high; twigs glabrate; leaves 20 by 20 cm., conspicuously 3-lobed, the sides of the lobes straight, giving the appearance of a maple leaf, glabrous or nearly so above, scantily covered with slender branched hairs beneath; flower, 14 cm. long; calyx tube 5 cm. long, spreading above, at first granular-puberulent, becoming glabrate; calyx lobes nearly uniform in outline, not carinate, nearly as broad as long, 3 cm. long, densely tomentose on back, ciliate; petals

surpassing the calyx lobes, oblong-spatulate, 3.5 cm. wide, conspicuously parallel-veined.

Type in the herbarium of the New York Botanical Garden, collected at Mamatoca, Santa Marta, Colombia, 1898–99, by Herbert H. Smith (no. 829). The collector states that the tree is "common locally near streams, at 500 to 2,500 feet. Flowers in December and January. Petals pale yellowish. The silk enveloping the seeds is used for pillows, etc., and is sold in the market (as 'lana') at Santa Marta. It is collected in May, when it is found scattered on the ground under the trees." We also refer to this species Broadway no. 4,418, collected March 8, 1913, in Tobago; also Père Duss. no. 3,634, April 10, 1895, from Guadelupe, and his no. 185, from Martinique, although the last two collections do not entirely agree with the type.

ORNITHOLOGY.—*Diagnosis of a new genus of Bucerotidae.*

HARRY C. OBERHOLSER, Biological Survey.

The family Bucerotidae at the present time is represented in the Philippine Islands by four genera. One of these, however, *Hydrocorax* Brisson, proves to be composite. This genus *Hydrocorax* was first instituted by Brisson for *Buceros hydrocorax* Linnaeus;[1] much later (1880) another species, *Buceros mindanensis* Tweeddale, was added by Elliot; and subsequently still another, *Buceros semigaleatus* Tweeddale, was referred to this group. The last-mentioned species, however, is clearly not congeneric, and should form the type of a separate monotypic genus which we here call:

Platycorax,[2] gen. nov.

Diagnosis.—Similar to *Hydrocorax* Brisson, but casque entirely different: in superior aspect smaller, shorter, and narrower in general outline (although the bird is actually larger), posteriorly narrower and not so truncate, the anterior portion sharply much constricted, so that the anterior third is much narrower than in *Hydrocorax*, and concave in outline instead of evenly convex throughout its length: in lateral aspect completely flattened anteriorly, with no vertical projection, the whole bill therefore much less in height;[3] feathered interramal space relatively as well as actually broader.

Type.—*Buceros semigaleatus* Tweeddale.

[1] *Hydrocorax* Brisson, Ornith. 4: 565. 1760. (Type by tautonymy, *Buceros hydrocorax* Linnaeus.)

[2] πλατύς, latus; κόραξ, corvus.

[3] These differences in the shape of the casque are well shown by the figures given in the Proceedings of the Zoological Society of London for 1878, pages 278–279.

Remarks.—This new genus differs so much from the other Philippine genera, and in fact from all of the genera of the *Bucerotidae*, that a close comparison is scarcely necessary. It is, of course, apparently most nearly allied to *Hydrocorax*, although it is so different in appearance from *Hydrocorax hydrocorax*, the type of that genus, that it is rather remarkable that it has not been separated before. It should be stated, however, that Dr. Edgar A. Mearns had noticed the very striking structural characters in *Hydrocorax semigaleatus* Tweeddale, and just before his untimely death had planned to create a new generic group for this species.

The third species commonly referred to the genus *Hydrocorax*, *Hydrocorax mindanensis* (Tweeddale), has a smaller casque than *Hydrocorax hydrocorax*, but it is of the same shape, and the species is without doubt correctly placed in the same genus. The type of our new genus, *Platycorax semigaleatus* (Tweeddale), is, therefore, its only species.

The only other generic name applied to any species of *Hydrocorax* is *Platyceros* Cabanis and Heine,[4] the type of which is *Hydrocorax hydrocorax;* so that it is, of course, a synonym of *Hydrocorax* Brisson.

By the present separation of *Platycorax*, there are now five genera of Bucerotidae in the Philippine Islands, of which four, including *Platycorax*, are endemic.

[4] Mus. Hein. 2: 174 1860

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors The abstracts should conform in length and general style to those appearing in this issue.

PHYSICS.—*The decrease in ultra-violet and total radiation with usage of quartz mercury vapor lamps.* W. W. COBLENTZ, M. B. LONG, and H. KAHLER. Bur. Stands. Sci. Paper No. 330. Pp. 20. 1918.

It is well known that the radiations emitted by quartz mercury vapor lamps decrease very markedly in intensity with usage of the lamp. The object of this investigation was (1) to devise methods for determining quantitatively the decrease in intensity of the emission with usage and (2) to make preliminary measurements on radiant power life-tests of quartz mercury vapor lamps.

The measurements of the radiations from these lamps were made by means of a thermopile. The ultra-violet rays were absorbed by means of a yellow glass and by this means it was possible to study the decrease in the ultra-violet radiation as well as the decrease in total radiation with usage of the lamp. It was found the intensity of the total radiation as well as the ultra-violet component, decreases to about one-half of its initial value in the course of 1,000 to 1,500 hours.

W. W. C.

PHYSICS.—*New Baumé scale for sugar solutions.* FREDERICK BATES and H. W. BEARCE. Bur. Stands. Tech. Paper No. 115. Pp. 11. 1918.

Many different Baumé scales have been proposed and used in the past. At the present time there are still in use in the United States three different scales for liquids heavier than water. Two of these, namely, the "Holland" scale and the "Gerlach" scale are used in sugar work. Neither is adapted to modern requirements. The new scale lies between the "Holland" and "Gerlach" scales and has three important advantages which should commend it for general use. They are;

1. It is based upon the specific gravity values of Plato, which are considered the most reliable of any available.

2. It is based on 20° C., the most convenient and widely accepted temperature for sugar work.

3. It is based on the modulus 145, which has already been adopted by the Manufacturing Chemists Association of the United States, by the Bureau of Standards, and by all American manufacturers of hydrometers. H. W. B.

SPECTROSCOPY.—*Measurements of wave-lengths in the spectrum of neon.* KEIVIN BURNS, W. F. MEGGERS, and P. W. MERRILL. Bur. Stands. Sci. Paper No. 329. Pp. 10. 1918

The lines in the neon spectrum are very sharp, a quality which recommends this gas as a standard source wherever the lines have sufficient strength. The ultra-violet group between 3,369A and 3,520A may be used for standards, and there are a few good infra-red lines, but the strength and distribution of the lines in the region 5,852A to 7,438A make the neon spectrum particularly useful as a comparison in this region.

The wave-lengths of fifty-five lines in the neon spectrum have been measured by means of the interferometer. These lines lie in the region 3,369A to 8,495A. The strong lines in the visible region of the spectrum have been observed with great accuracy, the probable error being one part in several millions, or less than one-tenth the width of the line. These strong lines were observed by means of three different pairs of interferometer plates which were each used on several interferometers. The ultra-violet lines and all the strong lines in the visible were compared directly with the fundamental standard 6,438A. Some of the deep red and infra-red lines were compared with well-determined lines in the visible neon spectrum.

One hundred and eighty-nine faint lines in the visible and infra red neon spectrum have been measured by means of a concave grating. The probable error of these grating measurements is one or two hundredths angstrom. The region covered by the grating observations extends from 5,343A to 8,783A.

The constant differences discovered by Watson are found to hold with remarkable exactness in the case of lines which are strong enough to be measured with the highest accuracy. In fact, the differences are exactly constant within the limits set by the accuracy of the wave-lengths. K. B.

ELECTRICITY.—*Electrical oscillations in antennas and inductance coils*. JOHN M. MILLER. Bur. Stands. Sci. Paper No. 326. Pp. 20. 1918.

The mathematical theory of circuits having uniformly distributed electrical characteristics, such as cables, telephone lines, and transmission lines, is applied to the oscillations in antennas and inductance coils.

It is shown how the frequency of the natural oscillation of an antenna may be determined analytically or graphically when inductance coils or condensers are inserted in the lead-in. Expressions are derived which permit the calculation of the effective resistance, inductance, and capacity of the antenna and it is shown that in so far as frequency or wave-length computations are concerned the simple formula applicable to ordinary circuits with lumped constants gives very accurate results. Experimental methods are given for determining the effective and static or low-frequency values of the antenna constants.

Inductance coils are likewise treated from the standpoint of the theory of distributed characteristics. Expressions are obtained for the reactance of the coil at any frequency and for the natural oscillations of a circuit of coil and condenser. It is further shown that, in so far as the frequency of oscillation is concerned, an inductance coil with distributed characteristics is equivalent to a pure inductance of constant value with a constant capacity across its terminals. Excepting for skin effect, this pure inductance would be the same as the low-frequency inductance of the coil. This explains a fact which has been frequently observed experimentally, in particular for single layer solenoids. J. M. M.

CERAMIC CHEMISTRY.—*The calculation of the rational analysis of clays*. HENRY S. WASHINGTON. Journ. Amer. Ceram. Soc. 1: 405–421. June, 1918.

This paper discusses briefly the factors that render the so-called "rational" analysis of clays uncertain, erroneous, and of little or no value for any purpose. A method for calculating from the chemical analysis the mineral composition, generally quartz, feldspar, and kaolin, is suggested, which is an application of the principles and method of calculating the "norm" of igneous rocks. In the case of clays the procedure is of great simplicity and accuracy, is very expeditious after the chemical analysis has been made, and yields results of great reliability. H. S. W.

CERAMIC CHEMISTRY.—*The effect of certain impurities in causing milkiness in optical glass.* C. N. FENNER and J. B. FERGUSON. Journ. Amer. Ceram. Soc. 1: 468–477. July, 1918.

In the manufacture of optical glass at one of the plants, a matter which gave considerable difficulty for a while was the occasional production of pots of glass which were affected by opalescence or milkiness. The evidence indicated that the source of the trouble lay in the sulphate and chloride content of the potash. The trouble disappeared when more reliable methods of temperature-control were installed, by which an assurance could be had of keeping the temperatures constantly at 1400° to 1420° C. Later, evidence was obtained which connected the milkiness quite definitely with the impurities mentioned, at least as regards the case under discussion, although in other cases the same effect is to be ascribed to other causes. Reasons are given for the conclusion that the milkiness is caused not by the separation of sulphates or chlorides themselves, but to some slight change in the physical properties of the melt which permits the separation of clouds of minute crystals of cristobalite. R. B. SOSMAN.

BOTANY.—*Naming wheat varieties.* CARLETON R. BALL and J. ALLEN CLARK. Journ. Amer. Soc. Agron. 10: 89–94. February, 1918.

Crop varieties should be designated by names that are short, simple, appropriate, easily spelled, and easily pronounced. The multiplication of names and other designations for crop varieties has been carried to great extremes. Present designations may be classed as follows: (1) Names, as Fultz or Kubanka; (2) descriptive phrases, as Early Red Clawson; and (3) numbers, as Minnesota no. 162. The existing confusion in names renders difficult the interpretation of published results of experiments. This confusion occurs in two principal ways: (1) The same name is applied to very different varieties in different parts of the country; (2) the same variety passes under several different names in different parts of the country, or even in the same part

It is desirable to prevent a continuation of such practices and to attempt a solution of the problems already existing. Accordingly, a brief but comprehensive code of nomenclature has been formulated.

CODE OF NOMENCLATURE

1. Eligibility to naming. No variety shall be named unless (*a*) distinctly different from existing varieties in one or more recognizable

characters, or (*b*) distinctly superior to them in some character or quality; and unless (*c*) it is to be placed in commercial culture.

2. Priority. No two varieties of the same crop plant shall bear the same name. The name first published (see Rule 4) for a variety shall be the accepted and recognized name except in cases where it has been applied in violation of this code.

3. Form of names. The name of a variety shall consist of a single word.

4. Publication. A varietal name is established by publication. Publication consists (1) in the distribution of a printed description of the variety named, giving its distinguishing characters, or (2) in the publication of a new name for a variety properly described elsewhere, such publication to be made in any book, bulletin, circular, report, trade catalog, or periodical, provided the same bears the date of issue and is distributed generally among agronomists and crop growers; or (3) in certain cases the general recognition of a name for a commercial variety in a community for a number of years may be held to constitute publication.

Paragraphs 1 to 4 have numerous additional clauses not given here which explain or interpret the rule. Paragraphs 5 and 6 deal with formal citation and with changes, respectively.

This code, essentially as presented, was officially adopted by the American Society of Agronomy in November, 1917.

C. R. B.

BOTANY.—*Effects of various salts, acids, germicides, etc., upon the infectivity of the virus causing the mosaic disease of tobacco.* H. A. Allard. Journ. Agr. Res. 13: 619–637. June 17, 1918.

The virus of the mosaic disease of tobacco was treated for various periods of time with different concentrations of acids, salts, etc., to determine their effect upon the infectivity. Nitric and hydrochloric acids, except in concentrations approaching one gram in 50 to 100 cc. of virus solution, affected the infectivity but little. Somewhat stronger solutions of citric, phosphoric, and acetic acid were required to affect the virus. Manganese sulphate, sodium chloride, aluminium sulphate, lithium nitrate, sodium nitrate, lead nitrate, silver nitrate, and mercuric chloride affected the virus but little under the conditions of the experiments. Carbolic acid, creolin, cresol, and phenol affected the infective principle only slightly under the conditions of the experiments, and there was no appreciable difference in their relative effects. Acetone

destroys the infective principle much less readily than ethyl alcohol. In ethyl alcohol the infective principle is destroyed rather quickly in alcoholic solutions stronger than 50 to 55 per cent. Eighty per cent alcoholic strengths killed the virus in less than half an hour. Chloral hydrate, benzoate of soda, quinine bisulphate, naphthalene crystals, camphor, thymol, and glycerin, except in very strong solutions, reduced the infectivity of the virus but little. The virus shows itself considerably more susceptible to solutions of formaldehyde, a 4 per cent strength destroying the infective principle very quickly. When the virus is mixed with talc, kaolin, or soil, it frequently loses its infectious properties more quickly than when merely bottled without the addition of any preservative. H. A. A.

PHYTOPATHOLOGY.—*A serious eelworm or nematode disease of wheat.* L. P. BYARS. U. S. Dept. Agr. Circ. 114. July, 1918.

During the past year the eelworm disease of wheat, caused by *Tylenchus tritici* (Steinbuch) Bastian and long known in Europe, has been found causing a great deal of damage in certain parts of the United States, particularly in Virginia. Recent examinations have shown a loss in some fields of as much as 40 per cent of the crop.

Wheat spikelets affected by the disease contain in place of the normal kernels dark, hard galls filled with larvae of the nematode. These larvae escape from the galls into the soil, reach the young seedlings, become located between the leaf sheaths near the bud and are passively elevated to the spikes. There they enter the young flowers and produce the galls within which they develop to maturity and lay eggs. The latter give rise to larvae and in this way their life cycle is completed.

The disease may be controlled by the use of clean seed, crop rotation, and sanitation. If uninfected seed cannot be brought in from localities where the trouble does not occur the sound grain may be separated from the nematode galls by floating off the latter in water.

L. P. B.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

BIOLOGICAL SOCIETY OF WASHINGTON

The 589th regular meeting of the Society was held in the Assembly Hall of the Carnegie Institution, Saturday, January 11, 1919; called to order at 8.00 p.m. by President SMITH; 26 persons present.

On recommendation of the Council the following named persons were elected to membership: GEORGE WILLETT, Los Angeles, and WALTER M. GIFFARD, Honolulu.

Deaths of the following named members were noted: Dr. HOWARD E. AMES and Dr. W. T. FOSTER.

The annual report of the treasurer was received and accepted.

Prof. A. S. HITCHCOCK presented the following proposed amendment to the by-laws: The President shall not be eligible for immediate reelection. To follow at the end of first paragraph of Article II of the by-laws.

President SMITH announced the membership of the Committee on Communications as: A. S. HITCHCOCK, L. O. HOWARD, A. WETMORE, R. E. COKER, J. W. GIDLEY; and of the Committee on Publications as: C. W. RICHMOND, J. H. RILEY, NED DEARBORN, W. L. MCATEE.

Under the heading of Brief Notes, Prof. A. S. HITCHCOCK referred to the work of the Committee on Generic Types of the Botanical Society of America, of which he is chairman. Under the same heading President SMITH referred to the mild winter so far experienced and its effects on the unusual blooming of certain spring-flowering plants. W. L. MCATEE, with reference to the same subject, called attention to the late blooming of some autumn-flowering species. In this connection Dr. L. O. HOWARD called attention to a publication on this same subject by Prof. L. F. WARD many years ago.

J. B. NORTON presented the first formal communication: *A new and easy way to recognize our local asters.* He said investigation of several local species of *Aster* showed great differences in the disk florets. These differences were utilized in a key for the separation of the species which it was suggested could be expanded to include all the forms in the vicinity of Washington. The utilization of similarly neglected characters in other difficult groups would be advisable. His remarks were illustrated by a series of well prepared diagrams showing the variations in the different structures of the disk flowers of *Aster.* Discussion by W. L. MCATEE and A. S. HITCHCOCK.

LYMAN CARRIER presented the second formal communication: *Dr. John Mitchell, an early naturalist and historian.* He gave a synopsis of his rather extensive investigations into the life of JOHN MITCHELL, an early physician in the English Colonies of America who was also noted for his work as a naturalist, historian, and cartographer. Much of his work is published anonymously and much of it is rare and rather inaccessible. Discussion by A. S. HITCHCOCK.

J. W. GIDLEY gave the third paper of the program: *Significance of the divergence of the first digit in the primitive mammalian foot.*

A. S. HITCHCOCK presented the last paper of the program: *A peculiar species of Lasiacis.* Discussion by T. S. PALMER. This paper appears in full in this JOURNAL (**9:** 35–38. January 19, 1919).

The 590th regular meeting of the Society was held in the Auditorium of the New National Museum, Saturday, January 25, 1919; called to order at 8.00 p.m. by President SMITH; 29 persons present.

On recommendation of the Council the following named persons were elected to membership: ERICH W. SCHWARTZE, Bureau of Chemistry; MYRON H. SWENK, University of Nebraska; R. C. McGREGOR, Bureau of Science, Manila.

Informal communications were presented as follows: General T. E. WILCOX: *Remarks on the berries of Mitchella.* President SMITH: *Exhibition of and remarks on a piece of baleen of the right whale of the Pacific Coast.* He stated that this species is nearing extinction as among 999 whales taken last year on the Pacific Coast but one was a right whale. He also referred to whale meat as human food. W. L. McATEE: *Reference to an old publication, 1783 to 1784,* in which it appears that peanuts and cotton were commonly raised about Washington at that time.

The first paper of the regular program was by G. DALLAS HANNA: *Additions to the avifauna of the Pribilof Islands, Alaska, including species new to North America.* In the collection of birds made on the Pribilof Islands, Alaska, during the period June, 1916, to September, 1918, there were 21 species which had not been secured there or reported therefrom before. Four of these had not previously been collected within the limits of North America.

Species new to North America and the Pribilof Islands: *Eunetta falcata,* Falcated Teal; *Heteroscelus brevipes,* Polynesian Tattler; *Thalassoaetus pelagicus,* Kamchatkan Sea Eagle; *Anthus spinoletta japonicus,* Japanese Pippit.

Species new to the Pribilof Islands only: *Brachyramphus marmoratus,* Marbled Marrelet; *Puffinus tenuirostris,* Slender-billed Shearwater; *Nettion crecca,* European Teal; *Aristonetta valisineria,* Canvas-back; *Clangula clangula americana,* American Golden-eye; *Arctonetta fischeri,* Spectacled Eider; *Oidemia deglandi dixoni,* Pacific White-winged Scoter; *Chen hyperborea hyperborea,* Snow Goose; *Branta canadensis hutchinsii,* Hutchin's Goose; *Numenius tahitiensis,* Bristle-thighed Curlew; *Haematopus bachmani,* Black Oyster-catcher; *Archibuteo*

lagopus sancti-johannis, Rough-legged Hawk; *Spinus pinus*, Pine Siskin; *Plectrophenax hyperboreus*, McKay's Snow Bunting; *Junco hyemalis hyemalis*, State-colored Junco, *Petrochelidon lunifrons lunifrons*, Cliff Swallow; *Hylocichla aliciae aliciae*, Gray-cheeked Thrush.

Some notes on the food habits and color phases of Rodger's fulmar, a common Pribilof bird, were given.

Discussion by A. S. HITCHCOCK, WM. PALMER, W. L. MCATEE for E. A. PREBLE, and by L. STEJNEGER.

The second and final paper of the regular program was by W. L. MCATEE: *An account of poisonous sumachs, Rhus poisoning, and remedies therefor.* Mr. MCATEE gave a detailed account of the classification and natural history of the poisonous sumachs, of the various theories as to why they poison, of the symptoms of poisoning, and of the host of remedies that have been employed against it. Discussion by Dr. V. K. CHESNUT.

The 591st meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, February 8, 1919; called to order at 8.00 p.m. by President SMITH; 53 persons present.

On recommendation of the Council, O. E. JENNINGS, Curator of Botany, Carnegie Museum, was elected to membership.

The following amendment to the By-laws read at the 589th meeting was favorably voted on by the Society: "The President shall not be eligible for immediate reelection;" to follow at the end of the first paragraph of Article II.

Under the heading of brief notes and exhibition of specimens, Dr. R. W. SHUFELDT exhibited seven lantern slides of pitcher plants, *Sarracenia purpurea*, taken about two years ago in an extensive swamp near Glen Burnie, Maryland. He pointed out that this plant is now practically extinct in the District of Columbia. After describing the main characters of this and related species he showed by means of one of the lantern slides some experiments he had been making with *S. purpurea* extending over an entire summer, the main features of which consisted in keeping a number of growing plants indoors and giving them a very limited amount of light. Gradually the new-coming leaves evinced an entire change of form and color. They became pale green with every semblance of markings effaced while the decided diminution in size was accompanied by a shrinkage of the wing, a change in outline, and an almost complete atrophy of the pitchers. In this connection Prof. W. P. HAY said one of his students had brought him a pitcher plant leaf stating it had been found in a locality near the city of Washington. Professor HAY had visited the alleged locality with the student, but they had been unable to find the rest of the plant. The student however was a reliable person and Professor HAY had no reason to doubt that the leaf had been found as stated. I. N. HOFFMAN presented an informal note on certain nesting habits of Shufeldt's junco.

The following formal communications were presented:

E. W. NELSON: *Dallia pectoralis, Alaska's most remarkable fish.* Mr. Nelson gave an account of the appearance and habits of this fish and described the important part it plays in the economic life of the natives of parts of Alaska. He related some of the myths concerning its vitality after freezing. Discussion by Dr. H. M. SMITH.

VERNON BAILEY: *The western skunk cabbage in its prime.* Mr. Bailey gave an account of the characters and natural history of this handsome plant and exhibited lantern slides of it in flower. Discussion by the chair and others.

M. W. LYON, JR.: *Isohemagglutinin groups of men.* Doctor Lyon defined the term isohemagglutination and gave a brief account of the discovery of the four well-recognized groups of men as determined by the action of the serum of each group upon the red blood corpuscles of the others. He pointed out that the first author to recognize the four groups as such was Jan Jansky' in a rather obscure publication in 1907 (Sborník Klinicky'-Arch. Bohèmes de Médécine Clinique **8**: 85–139. 1907). He designated these groups as I, II, III, and IV in the order of their frequency of occurrence. Moss, in 1910 (Bull. Johns Hopkins Hosp. **21**: 63–70. March, 1910), independently described the four groups and designated them, respectively, as IV, II, III, and I. As Jansky''s group I has the most active serum and the most resistant corpuscles Dr. Lyon suggested it might be called the *sthenic* group. For its direct opposite, Jansky''s IV, he suggested the term *antisthenic.* For the more common of the other two groups, II, and its opposite, III, he suggested the designations *parasthenic* and *antiparasthenic*, respectively. A lantern slide table showing the agglutinative action of the serums of 16 persons on the red blood corpuscles of the same persons was shown. A series of test tubes showing the action of sthenic, parasthenic, and antiparasthenic serum on corpuscles of each of these groups was exhibited. The antisthenic group is very rare and the speaker knew of no individual available belonging to that group when he prepared the demonstration tubes. Discussion by the chair, E. W. NELSON, W. P. TAYLOR, and others.

M. W. LYON, JR., *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

Preparations are being made for another expedition to the Mt. Katmai district in Alaska, under the auspices of the National Geographic Society. Professor ROBERT F. GRIGGS, of the Ohio State University, is director of the expedition, which will consist of photographic, surveying, topographic, and scientific parties. The scientific work will include studies of the revegetation of country devastated by ashfalls, and the zoology of the region at the foot of the Valley of Ten Thousand Smokes. In addition, a cooperating party from the Geophysical Laboratory of the Carnegie Institution, consisting of E. T. ALLEN, C. N. FENNER, and E. G. ZIES, will study the physics and chemistry of the fumaroles and the petrology of the Valley. The expedition will leave in May and return in September.

A joint influenza committee has just been created to study the recent epidemic and to make comparable, so far as possible, the influenza data gathered by the government departments. The members of this committee are: Dr. WILLIAM H. DAVIS, chairman, and Mr. C. S. SLOANE, representing the Bureau of the Census; Dr. WADE H. FROST and Mr. EDGAR SYDENSTRICKER of the Public Health Service; Col. D. C. HOWARD, Col. F. F. RUSSELL and Lieut. Col. A. G. LOVE, United States Army; Lieut. Commander J. R. PHELPS and Surgeon CARROLL FOX, United States Navy.

The proposed American Society of Mammalogists has issued an invitation to join in a movement to organize a society for the promotion of the interests and study of mammalogy. It is intended that the society shall devote itself to the subject in a broad way, including studies of habits, life histories, evolution, ecology, and other phases. Plans call for the publication of a journal in which both popular and technical matter shall be presented, for holding meetings, both general and sectional, aiding research and engaging in such other activities as may be deemed expedient. The organization meeting will be held in the New National Museum, Washington, D. C., April 3 and 4, 1919, sessions commencing at 10.00 a.m. and 2.00 p.m. No program of papers has been planned for this meeting.

The Committee on Organization is: HARTLEY H. T. JACKSON, Chairman, U. S. Biological Survey; WALTER P. TAYLOR, Secretary, U. S. Biological Survey; GLOVER M. ALLEN, Boston Society of Natural History; J. A. ALLEN, American Museum of Natural History; JOSEPH GRINNELL, University of California; N. HOLLISTER, National Zoological Park; ARTHUR H. HOWELL, U. S. Biological Survey, WILFRED H. OSGOOD, Field Museum of Natural History; EDWARD A. PREBLE, U. S. Biological Survey; WITMER STONE, Academy of Natural Sciences of Philadelphia.

Mr. A. A. BENEDICT, formerly of the University of Pittsburgh, has joined the staff of the Bureau of Standards as physicist in the sugar laboratory.

The following members of the Chemical Warfare Service have joined the staff of the Bureau of Standards since January: Captain J. M. BRAHAM, in the electrochemical laboratory; Lieut. C. W. CLIFFORD, sugar laboratory; S. C. LANGDON, electrochemical laboratory; F. W. REYNOLDS (formerly at Edgewood Arsenal), laboratory of metallurgical chemistry; P. WRIGHTSMAN, gas laboratory.

Mr. J. R. ECKMAN, formerly of the Ordnance Department, has joined the staff of the Bureau of Standards as chemist in the analytical laboratory.

Dr. GRAHAM EDGAR, formerly secretary of the Washington office of the Research Information Service, National Research Council, has resigned and is now with the Nitrate Division of the Ordnance Department of the Army. Mr. GORDON S. FULCHER is his successor as secretary of the Information Service.

Dr. C. S. HUDSON, Chief of the Carbohydrate Laboratory of the Bureau of Chemistry, resigned from the Bureau on February 12, 1919, and is now with the Samuel Heath Company, of Trenton, New Jersey.

Col. E. LESTER JONES, after service in the Army for about a year, both in America and France, has returned to his duties as head of the Coast and Geodetic Survey.

Dr. CHESTER N. MYERS, organic chemist of the Hygienic Laboratory, Public Health Service, resigned from the Service early in March, to organize a research laboratory for H. A. Metz and Company, manufacturers of local anesthetics and arsenicals, in Brooklyn, N. Y.

Mr. W. B. NEWKIRK, formerly with the Oxnard Sugar Company, has joined the staff of the Bureau of Standards as sugar technologist.

Capt. E. H. PAGENHART, of the U. S. Coast and Geodetic Survey, is now stationed at Fort Barrancas, Pensacola, Florida.

Captain L. L. STEELE, of the Ordnance Department, U. S. A., has joined the staff of the Bureau of Standards as chemist in the varnish laboratory.

Mr. A. F. STEVENSON, sanitary chemist with the Hygienic Laboratory, Public Health Service, resigned from the Service on March 1, to go into commercial research work in New York City.

Mr. C. W. STRATFORD, formerly of the Tidewater Oil Company, has recently come to the Bureau of Standards to take charge of an extensive investigation on the general subject of lubrication, with particular reference to the lubrication of internal combustion engines.

A Coast and Geodetic Survey party, under the direction of O. W. SWAINSON, is at work on the triangulation and topographic surveying of the Virgin Islands, recently acquired from Denmark.

Mr. E. D. WALEN, who for the past three years has been chief of the Textile Section of the Bureau of Standards and has been engaged in war research on the development of cotton fabrics as a substitute for linen for use in airplane wing surfaces, resigned from the Bureau in February and is now with the Textile Research Corporation at Boston, Massachusetts.

// JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 9 APRIL 4, 1919 No. 7

OPTICS.—*Trigonometric computation formulae for meridian rays.* P. V. WELLS, Bureau of Standards. (Communicated by S. W. Stratton.)

The design of optical instruments is notoriously so laborious and complicated that any simplification of notation, or shortening of labor, is important. By far the largest amount of labor is spent in tracing the actual path of selected rays through the tentative system by means of the trigonometric formulae. These formulae are simplest for logarithmic computation when referred to the center of curvature of the refracting surface instead of to its vertex. This is doubtless known to many designers but as I have not seen it in the literature, it may be useful to others.

The resulting formulae, using the notation defined in figure 1, where the subscript k refers to the k'th surface are:

$$\sin \theta_K = \frac{c_K}{r_K} \sin \alpha_K \tag{1}$$

$$\sin \theta'_K = \frac{n_K}{n_{K+1}} \sin \theta_K \tag{2}$$

$$\alpha_{K+1} = \alpha_K + \theta'_K - \theta_K \tag{3}$$

$$c'_K = r_K \frac{\sin \theta'_K}{\sin \alpha_{K+1}} \tag{4}$$

$$c_{K+1} = c'_K + d_{cK} \tag{5}$$

Where $c_K = r_K - u_K$, $c'_K = r_K - u'_K$, and $d_{cK} = d_K + r_{K+1} - r_K$ (6)

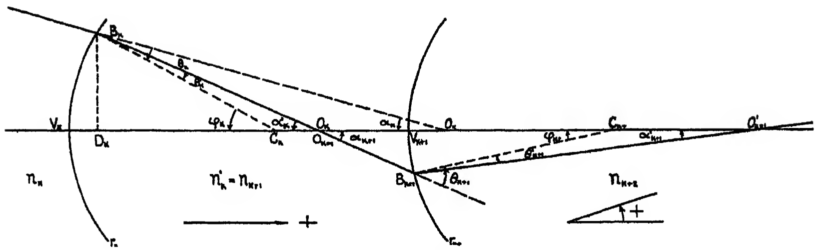

FIG. 1.—NOTATION.

Symbols referring to the object-space are unprimed, to the image-space are primed, the image-space for the k'th surface becoming the object-space for the (k + 1)'th surface.

K'TH REFRACTING SURFACE.

n_k = index of refraction, object-space.

n'_k = index of refraction, image-space.

VERTEX DISTANCES.

$r_k = \overline{V_kC_k}$ = radius of curvature.

$u_k = \overline{V_kO_k}$ = object distance.

$u'_k = \overline{V_kO'_k}$ = image distance.

$C_k = \overline{O_kC_k}$ = object distance (to center).

$C'_k = \overline{O'_kC_k}$ = image distance (to center).

$d_k = \overline{V_kV_{k+1}}$ = interval between vertices.

$d_{ck} = \overline{C_kC_{k+1}}$ = interval between centers.

SLOPE ANGLES.

$\varphi_k = \widehat{B_kC_kV_k}$ = slope angle of normal at incidence point.

$\alpha_k = \widehat{B_kO_kV_k}$ = slope angle of incident ray.

$\alpha'_k = \widehat{B_kO'_kV_k}$ = slope angle of refracted ray.

$\theta_k = \widehat{O_kB_kC_k}$ = angle of incidence.

$\theta'_k = \widehat{O'_kB_kC_k}$ = angle of refraction.

$h_k = \overline{D_kB_k}$ = incidence height (measured positively upward).

IDENTITIES.

$n'_k = n_{k+1}$.

$\alpha'_k = \alpha_{k+1}$.

There are two special cases which require consideration: (1) when u_K is infinitely great, and (2) when r_K is large (greater than ten times the focal length). In the first case, since $\varphi_K = -\theta_K$ when $u_K = \pm \infty$

$$\sin \theta_K = \frac{-h_K}{r_K}. \tag{7}$$

In the second case both c_K and c'_K are large. The formula usually given for this case, immediately derived from (*1*), (*4*), and (*6*), is

$$u'_K = u_K \frac{\sin \alpha_K}{\sin \alpha_{K+1}} \cdot \frac{\cos {}^1/_2(\alpha_{K+1} + \theta'_K)}{\cos {}^1/_2(\alpha_K + \theta_K)}. \tag{8}$$

The angles are computed as usual, and u_K is computed from the formula

$$u_K = r_{K-1} - c'_{K-1} - d_{K-1}. \tag{9}$$

The transfer of origin back to the center is made by use of (*5*) and (*6*), thus

$$c_{K+1} = r_{K+1} - u'_K + d_K. \tag{10}$$

There are apparently two special cases: (1) when the incidence is nearly normal, that is, when θ_K is small, and (2) when the refracted ray is nearly parallel to the axis, that is, when α_K is small, but in both cases formulae (*1*) to (*5*) may be used. Although c_K and c'_K are small when θ_K is small no precision is lost in c_{K+1} or in α_{K+1} which do not change in order of magnitude. Similarly when α_{K+1} is small no loss of precision occurs unless the interval between centers, d_{CK}, is large. This is evident from an expression of $\sin \theta_{K+1}$ which may easily be derived from (*4*), (*5*), and (*1*), namely

$$r_{K+1} \sin \theta_{K+1} = r_K \sin \theta'_K + d_{CK} \sin \alpha_{K+1}.$$

When α_{K+1} is small, θ_{K+1} is determined by θ'_K and the r's. The angles θ and α are both small only when r is large, a case which has just been considered in formula (*8*).

The theory of optical instruments is burdened by too much diversity in matters of convention. It seems inadvisable to depart from the time-honored conventions of geometry and trigonometry. Thus distances measured from left to right,

and angles measured by anti-clockwise rotation, are taken as positive in the notation of this paper.

The vertex of each surface is taken as the origin for its radius and for the object and image distances in refraction at that surface. The slope angles are measured from the rays in to the optic axis, and from the normal (to the surface at the incidence point) in to the axis, and the angles of incidence and refraction are measured from the rays in to the normal. Hence r and φ, u and α, u′ and α', and θ and θ' group in pairs having like sign As r is measured toward the center of curvature, it is convenient to measure both c and c′ toward the center. They are defined by equations (*6*), which have the advantage of symmetry as regards the signs of u and c

The quantities $\frac{1}{r_K}$, r_K, and d_K are constants for each surface, and their logarithms may be computed in a special column, copied on a slip of paper, and used directly for all rays. Similarly the logarithms of the ratios $\frac{n_K}{n_{K+1}}$ may be separately computed for each wave-length and used for all the rays of the same color.

For paraxial rays the angles θ and α are small quantities of the first order, so that sin θ may be replaced by θ, and cos θ by unity In this case the θ's and α's may be eliminated from equations (*1*) to (*4*), giving the Gauss formula

$$c'_K = \frac{n_K\, r_K\, c_K}{n_{K+1}\, r_K - (n_{K+1} - n_K)c_K}. \qquad (11)$$

If one must work alone, the constants may be checked by computing the paraxial rays both by (*1*) to (*4*), replacing the sines by the angles, and also by (*11*). Decimal trigonometric tables are most convenient, such as those published by the French government.

RADIATION.—*Note on the coefficient of total radiation of a uniformly heated enclosure.* W. W. COBLENTZ, Bureau of Standards.

Under the above title the writer published[1] a value of the so-called Stefan-Boltzmann constant of radiation from a uniformly heated enclosure or so-called black body. The value is $\sigma = 5.72 \times 10^{-12} \pm 0.012$ watt cm^{-2} deg^{-4}. It is based upon about 600 measurements, made with 10 receivers, which are summarized in table 6 of a previous publication.[2] The data obtained with receivers nos. 8 and 9 were not included because the apparatus was defective. The data obtained with these 10 receivers were corrected for radiation lost by reflection, which loss amounts to 1.2 per cent for receivers covered with lampblack (soot) and 1.7 per cent for receivers covered with platinum black. It does not include a set of measurements made on an unblackened radiator. The reflection from a receiver covered with platinum black, then smoked, is 1.2 per cent. These corrections were determined by direct measurements upon some of the receivers and by comparison of the surfaces of the other receivers with samples of lampblack whose reflection losses had been determined in a previous investigation.[3]

Experiments were made on atmospheric absorption and it was shown that if any correction to these data for atmospheric absorption is to be made, it can hardly be greater than 0.1 per cent.

Recently a new determination[4] of this radiation constant was brought to my attention, and in view of the fact that this paper contains inaccurate statements concerning my own work a few comments are permissible. For example, the statement is made that the only novelty in the apparatus employed by Coblentz and Emerson (*loc. cit.*) was a thermopile with a continuous receiving surface, which is of secondary importance. As a

[1] Proc. Nat Acad Sci. 3: 504. 1917.
[2] COBLENTZ and EMERSON. Bull. Bur. Stand. 12: 549. 1916.
[3] Bull. Bur. Stand. 9: 283. 1913.
[4] KAHANOWICZ. Nuovo Cimento (6) 13: 142. 1917.

matter of fact, the crucial part of the apparatus was a receiver with potential terminals attached thereto, at a sufficient distance from the ends to avoid the question of heat conduction to the electrodes. These potential wires, which were from 0.003 mm. to 0.02 mm. in diameter, accurately defined the length of the central part of the receiver which was utilized in the measurements. By exposing the whole length of the receiver to radiation, conduction losses did not enter the problem. The writer is not aware of anyone having used a similar apparatus which compares with this receiver in nicety of construction, and reproducibility of results under given conditions.

The receiver used by Kahanowicz was placed at the center of a spherical mirror, with an opening in one side to admit radiation. In this manner the correction for reflection was eliminated. The shutter was close to the receiver. If its temperature was different from that of the water-cooled diaphragm, which was before the radiator, errors in the radiation measurements would occur. As mentioned in my previous papers, the shutter should be placed between the water-cooled diaphragm and the radiator, to avoid a change in surroundings facing the receiver when the shutter is raised for making the radiation measurements. The temperature range was from 260° C. to 530° C. The distance from the radiator to the receiver was 35 to 55 cm. A series of 28 measurements gave an average value of $\sigma = 5.61 \times 10^{-12}$ watt cm^{-2} deg^{-4}. Of this number 11 gave a value of $\sigma = 5.7$. Out of a series of 4 measurements made in December, 1916, with the distance $d = 56$ cm., three gave a value of $\sigma = 5.7$.

No corrections were made for atmospheric absorption, which for the temperatures used is not negligible. In a previous paper[5] it was shown that on removing the moisture (vapor pressure of 10 to 12 mm.) from a column of air 52 cm. in length, the radiation constant was increased from $\sigma = 5.41$ to 5.55 or about 2.6 per cent. For the spectral region transmitted by rock salt, to $\lambda = 15\mu$, the absorption is about 1 per cent.[6] Other

[5] Bull. Bur Stand. 12: 576. 1916. See table 3, series CLXXX to CLXXXII.
[6] Proc. Nat. Acad. Sci. *Loc ,cit.*

measurements mentioned in these papers indicate an absorption of 2 to 3 per cent of the radiations emitted at 1000° C. for the average humidity of Washington.

Dr. H. H. Kimball, of the U. S. Weather Bureau, very kindly sent me comparative data, showing that the vapor pressures at Naples are considerably higher than at Washington. From these data it would appear that the correction for atmospheric absorption must be at least 1 per cent. For the low temperatures at which the radiator was operated, a fair estimate of the correction to the radiation data obtained by Kahanowicz is 1.5 to 2 per cent, or a value of $\sigma = 5.69$ to 5.72×10^{-12} watt cm^{-2} deg^{-4}. In other words, the Naples value of the coefficient of total radiation is comparable with other recent determinations which indicate a value of $\sigma = 5.7 \times 10^{-12}$ watt cm^{-2} deg^{-4}.

BIOLOGY.—*What kind of characters distinguish a species from its subdivisions?*[1] WILLIAM C. KENDALL, Bureau of Fisheries.

I do not claim to be an authority on Taxonomy, although I have labored to some extent in Systematic Ichthyology, which for a long time was to me a game of "follow the leader," and in which game, it may be said, I was a "blind" follower.

The fixed views of my leaders, regarding what kind of characters should constitute species and subspecies respectively, seemed thoroughly reasonable and logical, but when independently I attempted to apply them in practice, I found myself in a dense fog from which I have not yet emerged.

Briefly stated, a species was such by virtue of possessing one or more "distinct and constant" characters distinguishing it from all other species. These characters might be pronounced or slight, but if "constant" entitled the form so characterized to a binomial label. Of course if there was only one specimen, which was commonly the case, the above specific condition was fulfilled.

If, however, two forms, which, if observed by themselves in two separate localities, would seem to be distinct species, should

[1] Remarks at the Symposium at the meeting of the Biological Society, Saturday, March 8, 1919.

be found to intergrade geographically in characters from one terminus to the other, the one later described or named should be regarded as a subspecies and be given a trinomial name.

My preceptors further impressed upon me that a species and its subspecies could not develop in exactly the same environment.

I further learned that two forms though differing but slightly and suspected of intergradation should continue to be regarded as distinct species until intergradation should be proved.

As previously indicated, I subscribed to all this and am still willing to accept those *dicta* as gospel, and let them go at that. But the fog still hangs low. For that reason I cannot throw any light upon the question before us tonight. Beyond that which I have just stated no definite plan of procedure seems to have been advanced by any ichthyologist. In fact there seems to be no uniformity and little consistency in ichthyological classification, especially as pertains to species and the minor divisions of species.

I have more than once read or heard it stated that there is no such thing as species. If this be so, it would seem that there is a widely prevalent illusion and the systematists are seeing things. This would seem to be borne out by the fact that even certain recognized leaders appear to adhere to no definite system. In the same work one may find subspecies, species, and even genera based upon exactly the same kind or degree of differences, also good and valid species, according to the previously mentioned definition, considered identical with another species.

Unfortunately, or rather, fortunately if you please, we are limited to two sorts of names for the minor divisions of classification: binomial for species; trinomial for subspecies.

As I conceive of the objects of nomenclature, it is to afford a means of concisely designating certain situations. In regard to this point the question before us tonight seems to me to be: How many of the various situations, if more than one, shall be included in the binomial and how many in the trinomial designation? For it must be recognized that if the previously mentioned definitions of species and subspecies are accepted without modifications or limitation, there are several situations for which no provision has been made.

Ichthyologically, I, myself, discern two kinds of phantoms, which I designate as species. One is a taxonomic species, the other a natural species. At times they may blend into one but not always. Both conform to the definition given by my leaders and both imply development of one form from another, but there are two lines of development or derivation to be considered which I will designate as horizontal and vertical. The first refers to derivation, development, and relationships on the surface plane of a given time, past or present. The second, to derivation and development in time from the past to the present. Any cross-section of the vertical will present a horizontal plane of development. In taxonomic considerations of species and their subdivisions of living fishes, the tendency appears to be to regard them in their horizontal aspect. That is, in their relations to each other in the period of time in which they exist. If the vertical is considered at all it is usually as though the organism of the past was the same as the present. For instance, it is stated that *Salmo salar sebago* is derived from *Salmo salar*, as though the parent stock was the same as the Atlantic salmon of today. It may or may not have been. That is a point to be considered vertically. My meaning may become clearer if we imagine a longitudinal section through the vertical from the past to the present time.

During some period of time, recent or remote, through limitations to interbreeding and other causes, it is conceivable that two horizontal extremes developed differences of character which graded in toward the center. The persistence to the present time of these interbreeding connections constitute a perfect intergradation geographically between the two extremes of the present time. Again, it is conceivable that by expansion geographically of one or the other or both of the differentiating extremes, there is an actual or relative contraction of the intermediate connections. In other words, there is a tendency toward segregation of the extremes through weakening of the interbreeding connections.

Both phylogenetically and taxonomically in this situation at the present time there can be only one species, notwithstand-

ing the fact, that, if we were ignorant of the existence of the connecting forms, the two extremes would be sufficiently different to be regarded as distinct taxonomic species.

Phylogenetically the form at the center of distribution would typify the species. The fact that one extreme or the other may be the center of distribution does not affect the question. Unfortunately the species of the present-day taxonomist is often already named and may have come from any point in the hypothetical area mentioned. It may or may not be one or the other extremes or it may or may not represent the center of distribution. Consequently a subdivision of the species may in like manner represent almost any point more or less remote from the locality represented by the taxonomic species. In fact, according to his niceties of discrimination or his idiosyncrasies, one might make any number of subspecies, or whatever subdivisions of a taxonomic species it is decided to call these geographical representatives of a single natural species.

Now, if the two lines of differentiation, previously mentioned as developing at each margin or extreme in more or less remote time, should gradually separate, leaving a gap in the intergradation thus restricting the interbreeding to two independent lines of further development, which proceed without further interruption to the present time, they would result in two related natural species, conforming to the specific taxonomic definition of species of the aforesaid authorities. The degree of difference between these two species would depend, partly at least, upon the remoteness of the period of divergence.

One of these independent lines, at one period or another, may have repeated either one or both of the previously mentioned situations. The more recent the divergence, the less distinct the differences, until at the present time they are perhaps almost indistinguishable from the first mentioned horizontal or real intergradation. In fact, they may be quite indistinguishable to the systematist having before him only small collections or collections from a few localities only.

Again, suppose that, in some past period of time, more or less remote, a small portion of one of the main divergent lines of

development, progressing without a differentiation at the margin, should be segregated—put off at a way station, so to speak—and, by virtue of little or no change of environment, should be retarded or arrested in its phylogenetic development. Then suppose that, at a later period, similar segregation takes place, which for like reasons is also retarded or arrested. Both of these forms, persisting in their isolation and limited interbreeding to the present day, to the horizontal observer would appear as two intermediate forms, that is to say, connecting links between the respective species resulting from each of the main lines of phylogenetic development, previously referred to. The result of the first mentioned segregation would resemble the species at the present end of the main line other than the one resulting from the line in which the segregation originated, more nearly than would the result of the later segregation. So, although they appear as intermediate forms between existing species, they are not. They represent, rather, vertical intermediates between the common ancestral stock and the one species at the present end of the line from which they themselves were segregated. They form no intergradation, continuous nor interrupted, between the living species, but between an ancestral species different from the present species, and are, therefore, living fossils as it were. They may have, and probably did pursue, some small degree of development themselves. They should, I believe, be regarded as distinct species.

In my hypothesis I have designated only two of this latter character. There might be many. The more there are, the more difficult would it be to recognize the situation. But when the intergradation is interrupted, as it is in these instances, and particularly where each form is somewhat isolated at the present time, as in such instances it is likely to be, I believe that specific definition of my leaders fit the cases. The interruptions are represented by certain characters, which, whether little or great, entitle the forms to specific designation. They are natural species and should be thus taxonomically recognized.

There occur to me two other situations that might be, in fact have been, mistaken for real intergradations.

One is due to the intermingling and interbreeding of two closely related species. It represents a reunion across lots of long separated relatives. Of course, the intergrading forms are hybrids and there is no question regarding the distinctness of the species producing them or the designations of the results of their crossing. The real problem is in recognizing the situation.

The other situation is that of degradation due to degeneration of certain characters. The irregularity of distribution of the various degrees of such degeneration, and the fact that all degrees, from apparently perfect individuals to extreme degeneration of parts or characters, are sometimes found in one locality, suggest physiological or pathological causes and are individual rather than specific or subspecific in their significance. Such forms are even now recognized as species or subspecies, but with no more justification than there would be in regarding a group of human beings affected with alopecia as constituting a distinct race. "A man's a man for a' that."

The foregoing hypothetical situations are all represented among fishes today, but are generally not correctly interpreted. Only correct diagnoses of these cases render practicable the uniform application of the previously mentioned definitions of species and subspecies. Then, "true intergradation" designates subspecies. All the other situations are specific.

EVOLUTION.—*Evolution through normal diversity*. O. F. COOK, Bureau of Plant Industry.

Mr. F. L. Lewton, of the United States National Museum, has brought to my attention a paper by Thomas Meehan, which contains the following passage:

The observations on this plant (*Impatiens fulva*) confirm records I have made during the past quarter of a century that there is an innate power to vary coexistent with the species itself, independent of any conditions of environment. This may be granted without prejudice to the proposition that changes can and do occur at times by the influence of environment, for which there is abundant evidence. It seems proper to present the strong facts on the former side, because of the modern tendency to exalt the latter as the prime motor in evolution.[1]

[1] *Contribution to the life-histories of plants, No. X.* Proc. Acad. Phila 1894: 53.

The statement and its context are significant, and the issue is fundamental, though obscured by much deductive reasoning. Inheritance of "acquired characters," the changes that are directly imposed or induced by the environment, is no longer credited, but the environment is still supposed to cause evolutionary changes indirectly, through the medium of selection. It has been argued in many ways that evolution must be due to environmental causes, but such inferences do not visualize against a biological background. Not only is current dialectic unclear in failing to recognize elementary distinctions between causal and conditional relations, but essential facts continue to be neglected and dangerous applications entertained, such as the theory of natural selection used in Germany to justify the war.

Historical interest may be claimed for the passage from Meehan on account of the definite recognition of normal diversity. The expression "power to vary" may be misunderstood as assuming a mysterious "principle" or hidden "mechanism of evolution," but evidently it refers to the concrete, visible fact of diversity as the general and normal condition among the members of species. "The variations must be from some natural law of evolution inherent in the plant itself" was an earlier expression of the same idea that normal evolutionary diversity is a general fact, not determined by environment.[2]

Darwin recognized variation as a general fact, but he was wont to consider the environment as the cause, and the belief in environmental causation became completely dominant in the minds of many of his followers. Meehan's conception of variation as independent of the environment was framed many years in advance of the formal recognition of heterism or normal diversity among the members of species as a general evolutionary fact. Owing to the preponderance gained by the Darwinian interpretation, the word variation had come with many writers to refer almost exclusively to differences of accommodation to environmental conditions. The new word heterism seemed

[2] T. MEEHAN. *On the agency of insects in obstructing evolution.* Proc. Acad. Phila. 1872: 237.

necessary as a means of referring definitely to the class of differences which Meehan had described as "innate," "inherent," and "coexistent with the species itself." In proposing the name heterism additional examples were given, and the phenomenon was associated with more specialized forms of diversity that are admitted generally to be independent of the environment, as sexes, castes, and dimorphic or polymorphic species.[3]

Darwin had made much of the agency of insects in developing the highly specialized floral organs of orchids and other plants, and such adaptive specializations had been accepted as evidence that the environment, acting through natural selection, is the active agent in evolution. Meehan's observations and reasoning led to the opposite view, that crossing by insects would tend to keep the species uniform, and would thus interfere with evolution, instead of carrying it forward. To him it appeared that special characters might develop more rapidly if peculiar strains were kept separate, instead of being crossed by insects.

Efforts have been made to demonstrate the power of selection to induce changes of characters, but without finding any consistent evidence. Progress appears to be made in cases where the desired variations occur, but there is nothing to show that variations in a particular direction can be induced by dint of selection, after a pure-bred stock has reached a condition of uniformity. Statistical investigators often assume that causal effects are demonstrated by proving that the average of any particular character can be raised by selective elimination, but it remains to be shown that there is anything definitely evolutionary in the shifting of averages. To hold logically the idea that selection is the actuating cause of evolution, it must be assumed that the selective elimination or cutting away of one character or part of a species causes the other parts to vary farther away from the selective stress, an assumption not supported by definite evidence.

Apart from the mutation theory, the alternatives of selective causation of evolution are the Lamarckian idea of direct influence

[3] O. F. Cook. *Aspects of kinetic evolution.* Proc. Wash. Acad. Sci. 8: 244. 1907.

of the environment, to which Darwin himself often inclined, and the idea of spontaneous variation within the species put forward by Meehan in opposition to Darwin. As a lifelong observer, familiar with many genera and species and large numbers of living plants, Meehan was competent to give testimony and he took an important step beyond Darwin in perceiving that diversity inside the species is independent of the environment. Nevertheless, the evolutionary bearing of diversity was still obscured because Meehan shared with Darwin the mistake of supposing that contrasted characters must tend to disappear, through the alleged "swamping effect of intercrossing," an idea that continues to be accepted by many because it appears reasonable from mathematical or statistical points of view. Galton's "law of ancestral regression" has been taken as a mathematical demonstration of the reality of a swamping effect.

In recent years the law of regression has been applied to alternative inheritance as well as to quantitative or blended characters, and no longer seems to require the assumption of an underlying tendency for the members of an interbreeding group to reach a stable or uniform condition. Inheritance is seen to be alternative rather than equational, as shown by intensive studies of Mendelism and other methods of descent. Many divergent or contrasted characters persist in hybrid populations, instead of being obliterated or averaged away to uniformity. Even when the hybrid offspring are closely alike in the first or conjugate generation, ancestral differences may reappear undiminished in the perjugate generations.

The so-called recessive characters that can be transmitted for many generations without coming into expression, as well as reversions or reappearances of characters of remote ancestors, afford striking evidence that transmission is distinct from expression, and that transmission is permanent, while expression is readily changed. Phenomena of variation and diversity are largely differences of expression, including accommodations, or varied expressions of adaptive characters, to suit different conditions of existence.

It was necessary to discard the idea of diversity being lost through crossing, before it could be understood that new characters might be preserved in natural species without the individuals being segregated, by selection or otherwise. Preserving the adaptive variations no doubt facilitates evolution in directions of increased fitness, but the argument from fitness is far from proving that changes of characters are caused by selection. We say that cold weather makes us put on overcoats, but not that overcoats are made by cold weather. Species become adapted through variation. Each separate group is a distinct evolutionary system for developing new characters, some of adaptive value and others not. How characters are originated and preserved in transmission are questions that relate to the mechanism of heredity, but the nature of the mechanism of evolution is obvious. A very effective way of extending and combining any characters that variation may afford is provided by the organization of each species into a continuous fabric of lines of descent, united through sexual reproduction.[4]

Endless individual diversity results from the continued development and gradual diffusion of inherited characters among the members of a species. To find the diagnostic characters, those that are shared by all the members of one species but are absent from related species, often requires very patient and persistent work by systematists. Sometimes it is impossible to determine, even from many specimens, whether one species or more than one is represented. The groups must be canvassed in nature to learn whether they are continuous or not, so great and multifarious are the individual differences, while the general similarities are obscure and difficult to state.

With diversity accepted as a normal and general condition in species, evolution is seen as a process of continous integration and differentiation of characters. The two essential conditions of evolutionary progress are normal diversity (heterism) and free intercrossing of lines of descent (symbasis), as in natural

[4] O. F. Cook. *The vital fabric of descent.* Proc. Wash. Acad. Sci. 7: 301–323. 1906. See also, *Methods and causes of evolution,* U. S. Dept. Agr. Bur. Pl. Ind. Bull. 136. 1908.

species of plants and animals. The most familiar example of heterism is the individual diversity of mankind, but the same condition is recognized as soon as we become sufficiently familiar with the members of other species of animals or plants. Diversity is reduced or eliminated temporarily by selective breeding, or propagation in single or narrow lines, but reappears when the natural condition of free interbreeding is restored. Instead of tending to impede evolution, intercrossing of lines of descent in species presents a condition most favorable for the preservation and extension of new characters. The development of multitudes of useless differences is the best evidence of spontaneous development of useful characters. "The prime motor in evolution," to use Meehan's words, "is an innate power to vary, coexistent with the species itself, independent of any conditions of environment."

Laboratory geneticists may believe that species consist normally of uniform, identical individuals, or may suppose that the members of species tend to become uniform or to remain uniform if placed under the same environmental conditions, but these assumptions are not based on familiarity with natural species. Theories may be projected and logical systems deduced from the assumption of uniformity, as though a world of uniform species really existed, just as mathematicians follow relations of symbols into space of four dimensions. Facts are often obscured by elaboration of conventional ideas. Wider application of biology in agriculture, eugenics, and sociology awaits clearer perception and presentation of the underlying evolutionary and environmental relations.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors The abstracts should conform in length and general style to those appearing in this issue.

PHYTOPATHOLOGY.—*Some of the broader phytopathological problems in their relation to foreign seed and plant introduction.* BEVERLY T. GALLOWAY. Phytopathology 8: No. 3. March, 1918.

In this paper the author briefly reviews the progress in organized coordinated medical sanitation and emphasizes the results in their relation to plant sanitation; outlines the history of plant-exclusion legislation and points out its bearing on systematic foreign seed and plant introduction; and describes the present intensive work for the protection of new plant introductions against diseases and other enemies and suggests the approaching necessity of similar work for the country at large.

Certain principles are recognized in the work of the Office of Foreign Seed and Plant Introduction:

(1) That the work is international, and the broad phytopathological problems require world-wide consideration and study from the economic as well as from the phytopathological standpoint.

(2) That regulatory and restrictive measures, which are only palliative at best, must be internationalized to be most effective, and as such measures are generally highly profitable when properly administered they should receive the best support.

(3) That the science of plant hygiene, or the study of crops in relation to environment, offers the broadest field for research and applied science, and that this science will doubtless supplant many prevailing practices in phytopathology as preventive treatment is supplanting curative practices of the old-school physician.

The need of phytopathological surveys—local, national, and international—is strongly evidenced in the agricultural exploration work, so strongly in fact that the question arises as to whether the risk of introducing injurious diseases and insects is not too great to warrant general agricultural explorations and consequent seed and plant introductions, with no check except the necessarily imperfect examinations after the material arrives.

Agricultural exploration and introduction work is an important function of the Government, but the time seems to be approaching when these explorations should be back-grounded by phytopathological surveys or the explorations and phytopathological work done simultaneously. Theoretically plants should be free from diseases and insects, and, although theoretically only, there is no reason why efforts should not be made to approach the ideal conditions in this respect.

The development of some phases of plant hygiene will require combined effort and coordinated action of pathologists and others. Systematic world-wide studies of the botanical relationships of some of our principal crops seem desirable, not only to obtain a foundation for intelligent action regarding the economic use of plants, but to aid in supplying material with which to fight our present plant enemies.

The gradual shifting of plant industries from one region to another is also an interesting study and is due in many cases to lack of proper appreciation or understanding of plant sanitation. Sanitation as a phase of hygiene must be considered. The removal of many causes of disease is practicable, but a vast amount of educational work must be done in this field before effective action can be secured. The individual can accomplish much, but only through the State can far-reaching results be brought about. The State, however, is moved in such matters only by a groundswell of public opinion, and the best way to create a groundswell for plant sanitation is to bring the individual grower to a realization of its importance in all phases of his work.

B. T. G.

GENETICS.—*A study of hybrids in Egyptian cotton.* THOMAS J. KEARNEY and WALTON G. WELLS. Amer. Nat. 52 : 491–506. Oct.-Nov., 1918.

Hybrids were made between two varieties of Egyptian cotton, Pima and Gila, both of which had presumably originated by mutation. The two varieties, as represented by the progenies grown from selfed seed of the individuals which were the parents of the hybrids, differed significantly in their means for some two dozen characters. Most of these are size or shape characters. The parental ranges for nearly all characters overlapped considerably.

With very few exceptions, the means of the simple intervarietal hybrids, in the first, second, and third generations, fell between the parental means. The $^7/_8$ backcrosses obtained by twice crossing the

simple hybrid with either parent were practically identical with the preponderant parent in the means and ranges of the characters studied.

The simple hybrids showed little or no evidence of dominance in the F_1 nor of segregation in definite ratios in the F_2, the F_2 distributions having been, practically without exception, unimodal. None of the hybrid plants appreciably exceeded the combined parental ranges in respect to any character, while in the F_2 of wider crosses, *e. g.*, between Egyptian and Upland cottons, extraparental characters are abundantly expressed.

The second and third generations of the simple hybrids, as compared with the parents after two and three generations of selfing, were not more variable than the more variable Gila parent and were only a little more variable than the Pima parent. This points to the possibility of obtaining relatively stable and uniform recombinations of the desirable characters of varieties belonging to the same general type, while breeders have found it well-nigh impossible to "fix" wider crosses such as those of Egyptian (or Sea Island) with Upland cotton.

T. H. K.

ZOOLOGY.—*The criterion of subspecific intergradation in vertebrate zoology.* HARRY C. OBERHOLSER. Science, n. ser. 48: 165–167. 1918.

Intergradation is now generally accepted as the criterion of zoological subspecies. What constitutes subspecific intergradation, however, seems to be still debatable, particularly that kind of intergradation represented by individual variation in a form geographically separated from all other races of the species. This is illustrated by the case of *Aphelocoma californica* and *Aphelocoma californica sumichrasti*, the ranges of which are widely separated by intervening forms which have not, in all cases, direct geographic intergradation, although the individual variation in the latter overlaps that in the former. If in such cases we are to consider the two forms as distinct species, we must, to be consistent, treat all island and isolated alpine forms as distinct species however slightly and inconstantly they may be differentiated. The logical course, however, seems to be to consider this individual variation as equivalent to contiguous geographical intergradation, and thus regard individual variation as one of the chief criterions of subspecific intergradation. H. C. O.

MAMMALOGY.—*The Wisconsin Napaeozapus.* HARTLEY H. T. JACKSON. Proc. Biol. Soc. Wash. 32: 9–10. February 14, 1919.

The cooperative field work of the U. S. Biological Survey and Wisconsin Geological and Natural History Survey during the summers of 1917 and 1918 resulted in the collection of seven specimens of *Napaeozapus* from four localities in northern Wisconsin. This is a definite westerly extension of the previously known geographic range of the genus. The Wisconsin animal represents a clearly defined form which is named *Napaeozapus insignis frutectanus*. H. H. T. J.

ENTOMOLOGY.—*The case of the genera Rhina and Magdalis.* W. DWIGHT PIERCE. Proc. Ent. Soc. Wash. **20**: No. 4. Pp. 72–78. September 27, 1918.

This article straightens out a peculiar nomenclatorial tangle of these two genera, and gives tables of the subgenera of *Magdalis* and of the North American species of the genus. This is the first attempt at a coordination of the European and American classifications of this group. W. D. P.

ORNITHOLOGY.—*The migration of North American birds. III. The summer and hepatic tanagers, martins, and barn swallows.* HARRY C. OBERHOLSER. Bird Lore 20: 145–152. 1918.

The tables of migration data in this paper concern the following species, together with their subspecies: *Piranga rubra, Piranga hepatica*, *Progne subis*, and *Hirundo rustica.* By means of these tables it is possible to trace the migratory movements of these species both in spring and in autumn, from north to south. In addition, the breeding and winter ranges of each of the species and subspecies are given, together with the same information for *Progne cryptoleuca* and *Progne chalybea*, both of which, however, cannot be considered as of regular occurrence in North America. The average of arrival and departure at the various localities are in some cases based on records extending over as many as thirty-two years, though in most cases considerably less. H. C. O.

ORNITHOLOGY.—*The common ravens of North America.* HARRY C. OBERHOLSER. Ohio Journ. Sci. **18**: 213–225. May, 1918.

The subspecies of the common raven, *Corvus corax* Linnaeus, are among the most difficult birds of the family Corvidae. The differ-

ences characterizing them are almost wholly those of size and proportion, and, because great individual variation complicates the case, these are largely average distinctions and require series of specimens for proper elucidation. In the old world some sixteen or seventeen forms are at present recognized, but in North America currently only two, *Corvus corax principalis* of northern North America, with which the birds in the eastern United States are considered identical, and *Corvus corax sinuatus* of the western United States and Mexico. In addition to these, another smaller form, *Corvus corax clarionensis*, recently described from Clarion Island in the Revillagigedo group, of western Mexico, now appears to be the race inhabiting western North America from Lower California and Arizona to Oregon. The bird of eastern North America from Alabama to southern Labrador, and west to Minnesota and Arkansas, is described as a new race—*Corvus corax europhilus*. H. C. O.

ORNITHOLOGY.—*Birds observed near Minco, central Oklahoma.* ALEXANDER WETMORE. Wilson Bull. **30**: 2–10, 56-61. 1918.

Lists of breeding birds from Oklahoma are particularly important since little information is available concerning the geographic distribution of birds in this state. This contribution comprises notes on sixty-two species and subspecies, mostly breeding birds from the vicinity of Minco, in the central part of the State. The most interesting information from a distributional standpoint is the residence here of *Penthestes carolinensis agilis*, *Muscivora forficata*, *Agelaius phoeniceus predatorius*, *Dryobates pubescens medianus*, and *Thryomanes bewickii cryptus*; and the occurrence during migration of *Chordeiles minor henryi*. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Notes on the genus Puffinus Brisson.* HARRY C. OBERHOLSER. The Auk **34**: 471–475. October, 1917.

The notes in this paper relate to the generic groups, species, and subspecies currently included in the genus *Puffinus* Brisson, particularly such as concern North America. The new genus *Calonectris*, proposed by Mathews and Iredale for *Puffinus leucomelas* and *Puffinus kuhlii*, appears to be well characterized. The genus *Ardenna* Reichenbach is likewise tenable and includes *Puffinus gravis* O'Reilly, *Puffinus creatopus* Coues, and also *Puffinus carneipes* Gould, which has recently been made

by Iredale the type of a new but untenable genus, *Hemipuffinus*. For *Puffinus cuneatus* Salvin and *Puffinus chlororhynchus* Lesson, a separate generic group seems necessary, for which the name *Thyellodroma* Stejneger is available. Neither the proposed genus *Alphapuffinus* Mathews, to include *Puffinus assimilis*, *Puffinus lherminieri*, and *Puffinus persicus*, nor *Neonectris* Mathews, proposed for *Puffinus tenuirostris tenuirostris*, *Puffinus tenuirostris brevicaudus*, and *Puffinus griseus*, are generically separable from typical *Puffinus*. The action of Mathews in renaming the *Puffinus opisthomelas* of Coues as *Puffinus couesi* and the transference of the name *Puffinus opisthomelas* to the species commonly known as *Puffinus auricularis* proves to be unwarranted, since an examination of the types of both *Puffinus auricularis* and *Puffinus opisthomelas* show that they belong, respectively, to the species to which the names have commonly been applied. The *Puffinus couesi* of Mathews therefore becomes a synonym of *Puffinus opisthomelas* Coues. Furthermore, the subspecies of *Thyellodroma cuneata* (Salvin) recognized by Mr. Mathews prove to be, on re-examination of pertinent material, all untenable. H. C. O.

TECHNOLOGY.—*Toluol recovery.* R. S. McBride, C. E. Reinicker, and W. A. Dunkley. Bur. Stand. Tech. Paper No. 117. Pp. 60. 1918.

The importance of high explosives in the present war has been amply demonstrated. Nearly all types of explosives are used in some way, but trinitrotoluol, commonly known as T. N. T., because of its high power and great stability, is one of the preferred explosives. As an important constituent in shells, T. N. T. is used both alone and mixed with other explosives. Especially for naval use it is used alone, because the greater stability permits longer storage of the shells before use. On account of the great demand for T. N. T. there has grown up also a large demand for those materials for which it is made, especially toluol. This material finds numerous applications in the chemical industries, but particularly it has been used in the manufacture of dyestuffs and for the preparation of T. N. T. For this latter it is only necessary to treat the toluol with nitric acid under proper conditions in order to produce the explosive, which is then refined by appropriate means to such degree of purity as is required for the use for which it is intended. R. S. M.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The Board of Managers met on February 24, 1919. Mr. FREDERICK V. COVILLE was elected vice-president to represent the National Geographic Society. A committee consisting of A. S. HITCHCOCK, ADOLPH KNOPF, and W. R. MAXON was appointed to recommend to the Board alternate plans for the sale of the *Proceedings* of the ACADEMY.

The meeting of the Board on March 10, 1919, was devoted to the consideration of nominees for membership.

ROBERT B. SOSMAN, *Corresponding Secretary.*

BOTANICAL SOCIETY OF WASHINGTON

The 134th regular meeting of the Society was held at the Cosmos Club at 8 p.m., Tuesday, March 4, 1919. Forty-eight members and six guests were present. Mr. G. HAMILTON MARTIN, JR., of the Bureau of Plant Industry, was elected to membership. The program consisted of the following papers:

A botanical trip to the Hawaiian Islands (with lantern): Prof. A. S. HITCHCOCK. During the summer and fall of 1916, the speaker visited the Hawaiian Islands, including in his travel the islands of Hawaii, Maui, Oahu, Kauai, Molokai, and Lanai. Hawaii, the largest island, is about 100 miles wide and contains about 4000 square miles. On this are the two highest peaks, Mauna Kea (13,825 feet) and Mauna Loa (13,675 feet), and the active volcano or lava pit, Kilauea. On Maui is the great crater of Haleakala, said to be the largest in the world. Honolulu is on Oahu; the Leper Colony on Molokai.

The three important industries are the raising of sugar, stock, and pineapples. The ranches are located mostly on Hawaii, Maui, Molokai, and Lanai, the largest being about 700,000 acres. As there are few streams or wells in the drier parts of the islands the water supply is, for the most part, rainwater stored in tanks.

The introduced ornamental trees and shrubs are numerous and conspicuous, and introduced weeds have supplanted the native flora in the vicinity of the inhabited parts of the island. Among the important or peculiar plants of the islands may be mentioned the koa (*Acacia koa*), a common and useful native forest tree; the algaroba (*Prosopis juliflora*, introduced from America; the lobelias, consisting of about 100 species and 5 genera of Lobeliaceae, most of the species being

arboreous and often palm-like in appearance; the silver sword (*Argyroxiphium sandwicense*), a composite with beautiful silvery leaves, growing on the bare lava slopes of Haleakala; and the apé (*Gunnera petaloidea*), of the family Halorrhagidaceae, with enormous circular leaf-blades. The ferns are very numerous in species and individuals, often dominating the flora, especially in wet regions. The tree ferns are conspicuous. They produce at the base of the leaf-stalk a mass of yellow wool called pulu, which is used for stuffing pillows.

Vegetation of Paradise Key and the surrounding Everglades (with lantern): Mr. W. E. SAFFORD. Paradise Key, an island in the heart of the Everglades of Florida, nearly ninety miles south of Lake Okechobee, is of great biological interest, as an example, within the limits of the United States, of a subtropical jungle unspoiled by man. It is reached by automobile, or by train and automobile from Miami, thirty-seven miles to the northeastward. Though the temperature sometimes falls below freezing point, the mildness of its climate is attested by the presence of many tropical plants including a number of lofty royal palms whose crests may be seen from a distance above the sky line of the forest. These palms have given the name Royal Palm State Park to a tract of land including Paradise Key, some of the near-by marsh-land, and a corner of pine-land, granted to the Florida Federation of Women's Clubs by the State Legislature and afterwards augmented by the gift of a public-spirited woman. The paper, which is to be included in a forthcoming publication of the Smithsonian Institution, treats of the climate and physical geography, the various plant formations, including water-plants, plants of the marshes, marsh-loving shrubs, forest trees, lianas, epiphytes, and undershrubs, and contains a short account of some of the most interesting plants of the neighboring pine-lands, with reference to the interdependence of the animals and plants of the region discussed, their geographical distribution and dissemination, and notes as to their economic importance to the aboriginal inhabitants of southern Florida.

CHAS. E. CHAMBLISS, *Recording Secretary*.

BIOLOGICAL SOCIETY OF WASHINGTON

The 592d meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, February 22, 1919; called to order at 8 p.m. by President SMITH; 42 persons present.

O. P. HOPKINS, Washington, was elected to membership.

Under the heading brief notes, Prof. A. S. HITCHCOCK and Dr. A. D. HOPKINS called attention to a recently issued book on the birds of Colombia by Frank M. Chapman.

The formal program was an address by the retiring president, Dr. J. N. ROSE: *Botanical explorations in Ecuador*.

Dr. ROSE gave an account of his recent botanical explorations in Ecuador. He spent three months in that country during the past summer and obtained some 6000 botanical specimens. He made two

sections from west to east, one from Guayaquil to Ambato and the other from Loja to Santa Rosa. He also traveled down the Andean Valley from San Antonio to Loja. He showed thirty slides made from photographs obtained during this trip. One of these showed a house made of the giant bamboo which grows in the mountain canyons and which forms such an important material in the building of houses along the coast of Ecuador. Dr. Rose collected several species of cinchona, a plant which is in use for the manufacture of quinine. Specimens of cinchona bark, ivory nut, and various tropical fruits which had been preserved in formalin were on exhibition.

Discussion by Messrs. H. M. SMITH, A. D. HOPKINS, A. S. HITCHCOCK, R. M. LIBBEY and others.

M. W. LYON, JR., *Recording Secretary.*

ENTOMOLOGICAL SOCIETY OF WASHINGTON

The 320th regular meeting of the Society was held March 6, 1919, in the Assembly Hall of the Cosmos Club.

There were present 33 members and 41 visitors.

The minutes of the 319th meeting were read and approved.

Messrs. RICHARD T. COTTON and J. C. FURMAN, both of the Bureau of Entomology, were elected to membership.

The Corresponding Secretary called attention to notices that he had recently received, one from Martinus Nijhoff of the Hague announcing that, since the removal of the submarine menace, he is in position to fill old and new orders for literature; and one from the publishers of *Genera insectorum* listing the parts already published, those to appear in 1919, and those that are out of print.

The program for the evening consisted of moving pictures made by the Department of Agriculture and showing the practical application of control measures against injurious insects.

Dr. HOWARD gave a brief talk concerning the application of moving pictures to education and extension work in science especially as relating to agriculture and entomology.

The first picture showed methods and apparatus for eradicating poultry pests and a form of sanitary poultry house. Dr. PIERCE made a few preliminary remarks by way of explanation of this picture.

The second picture illustrated the fumigation of citrous trees in California, and showed the various types of apparatus in use. The legends had not yet been inserted in this picture, and it was fully explained as run off by Mr. SASSCER.

The last picture showed the eradication of the pink boll worm of cotton in Texas. During the changing of the reels Mr. BUSCK gave a brief summary of the history of the invasion of this insect into the United States, and expressed the belief that the methods shown in the picture were responsible for the absolute extermination of this very serious pest from something over 10,000 acres of land.

R. A. CUSHMAN, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

The "United States Fixed-Nitrogen Administration" has been organized under the joint control of the Secretaries of War, Navy, Interior, and Agriculture. It will be a civilian organization, and is designed to take over and operate all the federal government plants designed for the fixation of nitrogen and the manufacture of ammonia and nitric acid.

William Bowie, Major of Engineers, U. S. Army, was honorably discharged on February 28, 1919, and has resumed his duties as Chief of the Division of Geodesy, U. S. Coast and Geodetic Survey.

Lieut. Paul C. Bowers, formerly with the Chemical Warfare Service in Washington, is now at the laboratories of E. I. du Pont de Nemours and Company, at Wilmington, Delaware.

Dr. Keivin Burns, of the Bureau of Standards, has returned after two months spent in visiting laboratories in Europe.

Mr. F. C. Clark, of the paper and textile laboratories of the Bureau of Standards, left the Bureau in March and is now with the American Writing Paper Company, at Holyoke, Massachusetts.

Messrs. Arthur L. Davis and H. H. Hield have been transferred from the Sheffield, Alabama, plant of the Nitrate Division, Army Ordnance, to the Arlington research laboratories of the Division.

Mr. L. A. Fischer has returned to the Bureau of Standards to resume his duties as Chief of the Division of Weights and Measures. During the war he was commissioned Major in the Ordnance Department and was engaged in supervising the construction and use of munitions gages.

Mr. E. W. Guernsey, formerly with the Chemical Warfare Service, is now at the research laboratories of the Brown Company, at Berlin, New Hampshire.

Dr. John Johnston resigned as Executive Secretary of the National Research Council in March, in order to accept an appointment as Professor of Chemistry in Yale University, at New Haven, Connecticut.

Mr. J. O. Lewis, superintendent of the petroleum experiment station at Bartlesville, Oklahoma, has been appointed chief petroleum technologist of the Bureau of Mines, to succeed Mr. Chester Naramore, who has resigned from the Bureau to join the Union Petroleum Company, at Philadelphia, Pennsylvania.

Lieut. Gerald H. Mains has returned from active service in France to resume work at the Bureau of Chemistry.

Dr. C. Hart Merriam has been elected chairman of the U. S. Geographic Board, as successor to the late Andrew Braid.

Prof. J. C. Merriam, of the University of California, has returned to Washington to act as Chairman of the National Research Council.

Mr. Robert L. Moore, of the Bureau of Standards, has been transferred to the rubber laboratory of the Bureau at the University of Akron, Akron, Ohio.

Dr. James A. Nelson has resigned from the Bureau of Entomology to take up farming near Mt. Vernon, Ohio, retaining a connection with the Bureau as collaborator.

Mr. John D. Northrop, of the Geological Survey, resigned at the end of January to enter the employ of an oil company at Cheyenne, Wyoming.

Capt. L. W. Parsons, formerly with the Chemical Warfare Service, is now at the Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology, Cambridge, Massachusetts.

Capt. H. C. Porter, of the Ordnance Department, U. S. A., is now with the Chemical Service Laboratories, Incorporated, at West Conshohocken, Pennsylvania.

Lieut. Col. Glenn S. Smith sailed for the Dominican Republic in March to make a preliminary inspection of topography with the purpose of organizing a topographic survey under the direction of the military government of the Republic.

Dr. T. Wayland Vaughan, accompanied by D. D. Condit, C. W. Cooke, and C. P. Ross, left New York on March 19 for the Dominican Republic, to make a preliminary inspection of the geology in preparation for a geological survey under the direction of the military government of the Republic.

Dr. H. S. Washington, of the Geophysical Laboratory, Carnegie Institution, has been elected a foreign member of the Reale Accademia dei Lincei of Rome.

A new edition of the Directory of the Academy and its affiliated societies (the "Red Book") was distributed early in March.

// JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 9 APRIL 19, 1919 NO. 8

MATHEMATICS.—*Strains due to temperature gradients, with special reference to optical glass.* ERSKINE D. WILLIAMSON, Geophysical Laboratory, Carnegie Institution of Washington.

In spite of the fact that the foundations of the mathematical theory of this subject were laid as long ago as 1879,[1] observers have overlooked the simplicity of many of the results and their bearing on practical problems. Some time ago we had occasion to evaluate the stresses that would occur in blocks of glass of various shapes under varying heat treatments and in the following pages we give the results obtained and some remarks on their interpretation.

To get a concrete idea of the nature of the problems, consider a sphere of glass originally homogeneous which is being heated at a uniform rate. Under this heating condition there is set up a determinate temperature gradient such that the outside layers are hotter than those inside. If the sphere were to consist of a number of detached spherical shells, these shells would separate, but if the sphere be solid, internal stresses are set up to counteract the separation effect. For mathematical purposes we may evidently consider these two actions as taking place separately, *i.e.*, we may consider each element of the sphere as undergoing an expansion due to the temperature effect and then being brought back to its equilibrium position by internal stresses.

[1] HOPKINSON, J. Messenger of Math. 8: 168. 1879.

A qualitative idea of the stresses can be immediately obtained. Suppose the black parts in figure 1 represent concentric shells which have become separated by the establishing of temperature differences from shell to shell. To bring these together again will require tensions radially in each of the white sections. The radial tension must increase from the center to the outside as each tension holds in the tension outside it. The effect will

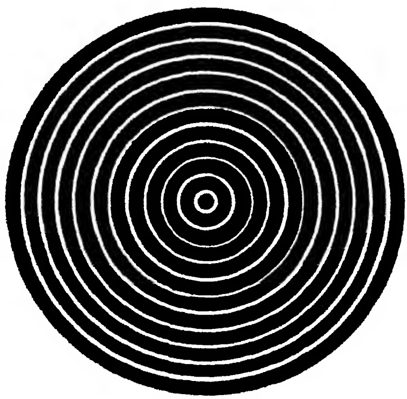

Fig. 1. Concentric Shells.

be radial stretching in all cases, but combined with the stretching in each shell there will be a total displacement inwards or outwards for the outer and inner shells, respectively, and this will result in a change of circumference which will be a decrease for the outer shells and an increase for the inner. The superposition of these effects gives the total strain.

MATHEMATICAL DISCUSSION OF PARTICULAR CASES

I. *Spherical shell with a temperature distribution which is symmetrical about the center.*—Let the infinitesimal shell whose radius is r become finally of radius $r + \rho$ so that $\frac{\rho}{r}$ = the tangential (or circumferential) strain and $\frac{d\rho}{dr}$ = the radial strain. Let P_r represent the radial stress at that point and P_t the tan-

gential. A tension is considered as a positive and a thrust as a negative stress. Then

$$\frac{d\rho}{dr} = e\,P_r - f\,P_t - fP_t + \alpha\theta \qquad (1)$$

$$\text{and } \frac{\rho}{r} = -f\,P_r + e\,P_t - f\,P_t + \alpha\theta \qquad (2)$$

where θ is the change in temperature from the initial condition of no stress, α is the coefficient of linear expansion and e and f are elastic constants for the substance.[2]

The condition of equilibrium shows that

$$P_t = P_r + \frac{r}{2} \cdot \frac{d\,P_r}{dr} \qquad (3)$$

Elimination of ρ and P_t yields

$$r\frac{d^2P_r}{dr^2} + 4\,\frac{dP_r}{dr} = -\frac{2\,\alpha}{(e-f)} \cdot \frac{d\theta}{dr}$$

and hence

$$r^3P_r = -\frac{2\,\alpha}{(e-f)}\int r^2\theta\,dr + C_1\frac{r^3}{3} + C_2 \qquad (4)$$

where C_1 and C_2 are constants to be evaluated by the boundary conditions. P_t is then evaluated from equation (3).

II. *Solid sphere with a temperature distribution which is symmetrical about the center.*—This differs from the previous case only in the evaluation of the integration constants. C_2 must vanish as $\frac{d\theta}{dr}$ and $\frac{dP}{dr}$ must be zero at r = o.

Hence

$$r^3P_r = -\frac{2\,\alpha}{(e-f)}\int r^2\theta\,dr + C_1\,\frac{r^3}{3} \qquad (5)$$

III. *Cylindrical shell or tube with temperature distribution symmetrical about the axis.*—In this case we made the assumption that planes perpendicular to the axis remained plane. Except at the ends this is justified and in fact it was found to be com-

[2] Young's modulus and Poisson's ratio, for the substance in question are $\frac{1}{e}$ and $\frac{f}{e}$, respectively.

pletely justified so far as experiment[3] was possible.

If the stresses be P_1, P_2, and P_3, parallel to the axis, radially, and tangentially in the plane at right angles to the axis, respectively, and X be the displacement parallel to the axis of the element originally defined by the coordinates (x, r), the elastic equations are:

$$\frac{dX}{dx} = eP_1 - fP_2 - fP_3 + \alpha\theta = \text{constant}$$

$$\frac{d\rho}{dr} = -fP_1 + eP_2 - fP_3 + \alpha\theta$$

$$\frac{\rho}{r} = -fP_1 - fP_2 + eP_3 + \alpha\theta$$

$$P_3 = P_2 + r\frac{dP_2}{dr}$$

$$\int_o^a P_1\, rdr = o$$

The last two equations are necessary for mechanical equilibrium and the substitution of a constant for $\frac{dX}{dx}$ is the form taken by the assumption mentioned above.

Elimination yields

$$(e-f)\frac{dP_1}{dr} + \alpha\frac{d\theta}{dr} = o$$

or

$$(e-f)\, P_1 + \alpha\theta = C_1 \tag{6}$$

also

$$3\frac{dP_2}{dr} + r\frac{d^2P_2}{dr^2} = -\frac{\alpha}{(e-f)}\cdot\frac{d\theta}{dr}$$

yielding

$$r^2P_2 = -\frac{\alpha}{e-f}\int r\theta dr + \frac{C_2r^2}{2} + C_3 \tag{7}$$

The value of P_3 is then obtained from

$$P_3 = P_2 + r\frac{dP_2}{dr}$$

[3] The experiments bearing on this will be published in the series of papers on optical glass now in the course of publication by this Laboratory.

IV. *Solid cylinder with temperature distribution symmetrical about the axis.*—The only change necessary is that C_3 in equation (7) vanishes owing to $\frac{dP_2}{dr}$ and $\frac{d\theta}{dr}$ being zero at $r = o$.

V. *Slab with temperature gradient through the smallest dimensions, symmetrical about the center.*—The same assumption was made as regards planeness as in the axial displacement for the cylinder and the forces along the line of the temperature gradient are neglected. (See previous footnote as regards experimental evidence.)

The equations then are:

$$eP - fP + \alpha\theta = \text{constant} = C_1$$

and

$$\int_o^a P dx = o$$

The integral gives us a method of evaluating the required constant,

$$\int_o^a \frac{C_1 - \alpha\theta}{e - f} dx = o$$

or

$$\int_o^a C_1 dx = \alpha \int_o^a \theta dx$$

APPLICATION OF THESE EQUATIONS TO SPECIFIC CASES[4]

I. *Spherical shell.*

(I*a*). *Shell heated linearly on the surface.*

(I*b*). *Approximate formulae for the same case when the internal diameter is very small.*

(I*a*).[5] In this case

$$\frac{d\theta}{dr} = \frac{hr}{3\kappa} - \frac{ha_1^3}{3\kappa r^2}.$$

Equation (4) therefore reduces to

[4] The temperature gradients $\left(\frac{d\theta}{dr}\right)$ in all cases are taken from a forthcoming paper on temperature distribution in solids, by E. D. Williamson and L. H. Adams.

[5] h = rate of heating; κ = diffusivity constant.

$$P_r = -\frac{2\alpha}{(e-f)}\left(\frac{hr^2}{30\kappa} + \frac{ha_1^3}{6\kappa r}\right) + \frac{C_1}{3} + \frac{C_2}{r^3}$$

But $P_r = 0$ at $r = a$ and $r = a_1$ so that C_1 and C_2 may be evaluated, yielding

$$P_r = \frac{\alpha h}{15\kappa(e-f)}\left[-r^2 - \frac{5a_1^3}{r} + \frac{a^5 + 5a^3a_1^2 - 6a_1^5}{a^3 - a_1^3} - \frac{a^5a_1^3 - 2a^3a_1^5 + a^2a_1^6}{(a^3-a_1^3)r^3}\right]$$

$$P_t = \frac{\alpha h}{15\kappa(e-f)}\left[-2r^2 - \frac{5a_1^3}{2r} + \frac{a^5 + 5a^3a_1^2 - 6a_1^5}{a^3 - a_1^3} + \frac{a^5a_1^3 - 2a^3a_1^5 + a^2a_1^6}{2(a^3-a_1^3)r^3}\right]$$

(I*b*). The values are obtained by assuming a_1 small enough to be negligible compared with a.

$$P_r = \frac{\alpha h}{15\kappa(e-f)}\left(-r^2 + a^2 - \frac{a^2a_1^3}{r^3}\right)$$

$$P_t = \frac{\alpha h}{15\kappa(e-f)}\left(-2r^2 + a^2 + \frac{a^2a_1^3}{r^3}\right)$$

II. *Solid sphere.* Linear heating, on outside surface.

The treatment is exactly as in the previous case and the resulting equations are:

$$\frac{d\theta}{dr} = \frac{hr}{3\kappa}$$

$$P_r = \frac{\alpha h}{15\kappa\,(e-f)}\left[-r^2 + a^2\right]$$

$$P_t = \frac{\alpha h}{15\kappa\,(e-f)}\left[-2r^2 + a^2\right]$$

Except at the center these agree with case (I*b*). At the center in the case of a sphere we have a tension in all directions of $\frac{\alpha\, ha^2}{15\kappa(e-f)}$ but if there be a very small cavity the stresses must be got from (I*b*), and it is found that the radial stress vanishes while the tangential tension is double the value for the solid sphere. It follows that small cavities, due for example to bubbles, make glass much more liable to breakage during heat treatment.

In the case of the solid sphere it is also interesting to find the elastic strains. These are got by substituting the values of P_r and P_t in equations (1) and (2). This yields

$$\text{Tangential extension}^6 = \frac{\alpha h}{15\kappa\left(\frac{1}{6n}+\frac{2}{9k}\right)}\left[\frac{a^2}{3k} - r^2\left(\frac{1}{6n}+\frac{5}{9k}\right)\right]$$

$$\text{Radial extension}^6 = \frac{\alpha h}{15\kappa\left(\frac{1}{6n}+\frac{2}{9k}\right)}\left[\frac{a^2}{3k} + r^2\left(\frac{1}{3n}-\frac{5}{9k}\right)\right]$$

The nature of these strains was predicted at the beginning of this paper, and it can be seen that in general the suggestions were correct. The radial extension is practically constant for it is approximately true for most solids that $4f = e$, which gives

$$\frac{1}{3n} - \frac{5}{9k} = 0.$$

On the other hand, the tangential extension is equal to the radial at the center, but diminishes, passes through zero and becomes a compression for larger values of r.

The form of these expressions shows that the stress at any point may be analyzed into a hydrostatic tension proportional to $a^2 - \frac{5r^2}{3}$ combined with a shearing stress which causes radial elongation and tangential contraction proportional to $1 + \frac{r^2}{3n}$ and $1 - \frac{r^2}{6n}$, respectively.

III. *Cylindrical tube.*

Since the analysis is exactly similar, only the bare results are written for the two cases considered, namely:

(III*a*). Linear heating, on outside only.

$$\frac{d\theta}{dr} = \frac{hr}{2\kappa} - \frac{ha_1^2}{2\kappa r}$$

[6] The values of the constants e and f are here expressed in terms of k (the compressibility modulus) and n (the rigidity modulus). $e = \frac{1}{3n} + \frac{1}{9k}$, $f = \frac{1}{6n} - \frac{1}{9k}$.

$$P_1 = \frac{\alpha h\left(\frac{a^2}{2} - r^2\right)}{4\kappa(e-f)} + \frac{\alpha h a_1^2}{4\kappa(e-f)}\left(\ln\frac{r^2}{a^2} - 1\right)$$

$$P_2 = -\frac{\alpha h r^2}{16\kappa(e-f)} + \frac{\alpha h a_1^2}{4\kappa(e-f)}\left(\ln r - \frac{1}{2}\right) + \frac{C_1}{2} + \frac{C_2}{r^2}$$

where C_1 and C_2 are evaluated by equating the right hand expression to zero for $r = a$ and $r = a_1$.

$$P_3 = -\frac{3\alpha h r^2}{16\kappa(e-f)} + \frac{\alpha h a_1^2}{4\kappa(e-f)}\left(\ln r + \frac{1}{2}\right) + \frac{C_1}{2} - \frac{C_2}{r^2}$$

where C_1 and C_2 have the values found for the preceding equation.

(III*b*). For a small-bored tube. Linear heating, on outside only.

$$P_1 = \frac{\alpha h(a^2 - 2r^2)}{8\kappa(e-f)}$$

$$P_2 = \frac{\alpha h\left(a^2 - r^2 - \frac{a^2 a_1^2}{r^2}\right)}{16\kappa(e-f)}$$

$$P_3 = \frac{\alpha h\left(a^2 - 3r^2 + \frac{a^2 a_1^2}{r^2}\right)}{16\kappa(e-f)}$$

(IV). *Solid cylinder.* Linear heating, on outside only.

$$\frac{d\theta}{dr} = \frac{hr}{2\kappa}$$

$$P_1 = \frac{\alpha h(a^2 - 2r^2)}{8\kappa(e-f)}$$

$$P_2 = \frac{\alpha h(a^2 - r^2)}{16\kappa(e-f)}$$

$$P_3 = \frac{\alpha h(a^2 - 3r^2)}{16\kappa(e-f)}.$$

(V). *Slab.* Linear heating, on outside only.

$$\frac{d\theta}{dr} = \frac{hr}{\kappa}$$

$$P = \frac{\alpha h}{2\kappa(e-f)}\left(\frac{a^2}{3} - r^2\right)$$

In all the cases except that of the sphere (for which the calculations are exact) it must be emphasized that the calculated stresses are the maximum values on the assumption that no relief takes place by bending. It will be shown in a later paper that the stresses actually occurring approximate very closely to the values thus calculated.

SUMMARY

General equations are derived for the elastic stresses produced by temperature differences in spheres, cylinders, and slabs when the temperature distribution is symmetrical about the center, axis, or central plane respectively.

More specific equations are given for the case of the temperature distribution due to uniform surface heating, which is the most important case in practice.

ASTRONOMY.—*Modern theories of the spiral nebulae.*[1] HEBER D. CURTIS, Lick Observatory. (Communicated by W. J. Humphreys.)

In one sense, that theory of the spiral nebulae to which many lines of recently obtained evidence are pointing, can not be said to be a modern theory. There are few modern concepts which have not been explicitly or implicitly put forward as hypotheses or suggestions long before they were actually substantiated by evidence.

The history of scientific discovery affords many instances where men with some strange gift of intuition have looked ahead from meager data, and have glimpsed or guessed truths which have been fully verified only after the lapse of decades or centuries. Herschel was such a fortunate genius. From the proper motions of a very few stars he determined the direction of the sun's movement nearly as accurately, due to a very happy selection of stars for the purpose, as far more elaborate modern investigations. He noticed that the star clusters which appeared

[1] Abstract of a lecture given on March 15, 1918, at a joint meeting of the Washington Academy of Sciences and the Philosophical Society of Washington. The lecture was illustrated with numerous lantern slides.

nebulous in texture in smaller telescopes and with lower powers, were resolved into stars with larger instruments and higher powers. From this he argued that all the nebulae could be resolved into stars by the application of sufficient magnifying power, and that the nebulae were, in effect, separate universes, a theory which had been earlier suggested on purely hypothetical or philosophical grounds, by Wright, Lambert, and Kant. From their appearance in the telescope he, again with almost uncanny prescience, excepted a few as definitely gaseous and irresolvable.

This view held sway for many years; then came the results of spectroscopic analysis showing that many nebulae (those which we now classify as diffuse or planetary) are of gaseous constitution and can not be resolved into stars. The spiral nebulae, although showing a different type of spectrum, were in most theories tacitly included with the known gaseous nebulae.

We have now, as far as the spiral nebulae are concerned, come back to the standpoint of Herschel's fortunate, though not fully warranted deduction, and the theory to which much recent evidence is pointing, is that these beautiful objects are separate galaxies, or "island universes," to employ the expressive and appropriate phase coined by Humboldt.

By means of direct observations on the nearer and brighter stars, and by the application of statistical methods to large groups of the fainter or more remote stars, the galaxy of stars which forms our own stellar universe is believed to comprise perhaps a billion suns. Our sun, a relatively inconspicuous unit, is situated near the center of figure of this galaxy. This galaxy is not even approximately spherical in contour, but shaped like a lens or thin watch; the actual dimensions are highly uncertain; Newcomb's estimate that this galactic disk is about 3,000 light-years in thickness, and 30,000 light-years in diameter, is perhaps as reliable as any other.

Of the three classes of nebulae observed, two, the diffuse nebulosities and the planetary nebulae, are typically a galactic phenomenon as regards their apparent distribution in space, and are rarely found at any distance from the plane of our Milky Way. With the exception of certain diffuse nebulosities

whose light is apparently a reflection phenomenon from bright stars involved within the nebulae, both these types are of gaseous constitution, showing a characteristic bright-line spectrum.

Differing radically from the galactic gaseous nebulae in form and distribution, we find a very large number of nebulae predominantly spiral in structure. The following salient points must be taken into account in any adequate theory of the spiral nebulae.

1. In apparent size the spirals range from minute flecks, just distinguishable on the photographic plate, to enormous spirals like *Messier* 33 and the Great Nebula in Andromeda, the latter of which covers an area four times greater than that subtended by the full moon.

2. Prior to the application of photographic methods, fewer than ten thousand nebulae of all classes had been observed visually. One of the first results deduced by Director Keeler from the program of nebular photography which he inaugurated with the Crossley Reflector at Lick Observatory, was the fact that great numbers of small spirals are within reach of modern powerful reflecting telescopes. He estimated their total number as 120,000 early in the course of this program, and before plates of many regions were available. I have recently made a count of the small nebulae on all available regions taken at the Lick Observatory during the past twenty years[2] and from these counts estimate that there are at least 700,000 spiral nebulae accessible with large reflectors.

3. The most anomalous and inexplicable feature of the spiral nebulae is found in their peculiar distribution. They show an apparent abhorrence for our galaxy of stars, being found in greatest numbers around the poles of our galaxy. In my counts I found an approximate density of distribution as follows:

Galactic Latitude $+45°$ to $+90°$	34 per square degree.
Galactic Latitude -45 to $-90°$	28 per square degree.
Galactic Latitude $+30°$ to $+45°$ and $-30°$ to $-45°$	24 per square degree.
Galactic Latitude $-30°$ to $+30°$	7 per square degree.

[2] CURTIS, H. D. *On the number of spiral nebulae,* Proc. Amer. Phil. Soc. **57**: 513. 1918.

No spiral has as yet been found actually within the structure of the Milky Way. We have doubled and trebled our exposures in regions near the galactic plane in the hope of finding fainter spirals in such areas, but thus far without results. The outstanding feature of the space distribution of the spirals is, then, that they are found in greatest profusion where the stars are fewest, and do not occur where the stars are most numerous. This distribution may be illustrated graphically as follows:

THE FACTORS OF SPACE DISTRIBUTION

400,000 ± Spiral Nebulae

Our own stellar universe
is shaped like a thin lens, and is perhaps
3,000 by 30,000 light-years in extent. In this
space occur nearly all the stars, nearly all the new stars, nearly
all the variable stars, most of the diffuse and
planetary nebulae, etc., but *no spiral
nebulae.*

300,000 ± Spiral Nebulae.

4. The spectrum of the spirals is practically the same as that given by a star cluster, showing a continuous spectrum broken by absorption lines. A few spirals show bright-line spectra in addition.

5. The space-velocities of the various classes of celestial objects are summarized in the following short table:

TABLE

THE FACTORS OF SPACE-VELOCITY

1. *The Diffuse Nebulae.*
   Velocities low.
2. *The Stars.*
   Velocities vary with spectral type.
   Class B Stars: average speeds 8 miles per second.
   Class A Stars: average speeds 14 miles per second.
   Class F Stars: average speeds 18 miles per second.
   Class G Stars: average speeds 19 miles per second.
   Class K Stars: average speeds 21 miles per second.
   Class M Stars: average speeds 21 miles per second.
3. *The Star Clusters.*
   Velocities unknown.
4. *The Planetary Nebulae.*
   Average speeds 48 miles per second.
5. *The Spiral Nebulae.*
   Average speeds 480 miles per second.

The peculiar variation of the space-velocity of the stars with spectral type may ultimately prove to be a function of relative mass. The radial velocities of but few spirals have been determined to date; future work may change the value given, but it seems certain that it will remain very high.

It will be seen at once that, with regard to this important criterion of space-velocity, the spiral nebulae are very distinctly in a class apart. It seems impossible to place them at any point in a coherent scheme of stellar evolution. We can not bridge the gap involved in postulating bodies of such enormous space velocities either as a point of stellar origin, or as a final evolution product.

On the older theory that the spirals are a part of our own galaxy, it is impossible to harmonize certain features of the data thus far presented. If this theory is true, their grouping near the galactic poles, inasmuch as all evidence points to a flattened or disk form for our galaxy, would indicate that they are relatively close to us. In that event, we should inevitably have detected in this class of objects proper motions of the same order of magnitude as those found for the stars at corresponding distances. Such proper motions are the more to be ex-

pected in view of the fact that the average space velocity of the spirals is about thirty times that of the stars. I have repeated all the earlier plates of the Keeler nebular program, and was able to find no certain evidence of either translation or rotation in these objects in an average time interval of thirteen years.[3] Their form, and the evidence of the spectroscope, indicate, however, that they are in rotation. Knowing that their space-velocities are high, the failure to detect any certain evidence of cross motion is an indication that these objects must be very remote.

Even if the spiral is not a stage in stellar evolution, but a class apart, is it still possible to assume that they are, notwithstanding, an integral part of our own stellar universe, sporadic manifestations of an unknown line of evolutionary development, driven off in some mysterious manner from the regions of greatest star density?

A relationship between two classes of objects may be one of avoidance just as logically as one of contiguity. It has been argued that the absolute avoidance which the spirals manifest for the galaxy of the stars shows incontrovertibly that they must, by reason of this very relationship of avoidance, be an integral feature of our galaxy. This argument has proved irresistible to many, among others to so keen a thinker as Herbert Spencer, who wrote:

> In that zone of celestial space where stars are excessively abundant nebulae are rare; while in the two opposite celestial spaces that are furthest removed from this zone nebulae are abundant . . . . . Can this be mere coincidence? When to the fact that the general mass of the nebulae are antithetical in position to the general mass of the stars, we add the fact that local regions of nebulae are regions where stars are scarce . . . . . does not the proof of a physical connection become overwhelming?

It must be admitted that a distribution, which has placed three-quarters of a million objects around the poles of our galaxy, would be against all probability for a class of objects which would be expected to be arranged at random, unless it can be shown

[3] CURTIS, H. D. *The proper motion of the nebulae.* Publ. Astron Soc. Pacific 27: 214. 1915.

that this peculiar grouping is only apparent, and due to some phenomenon in our own galaxy. This point will be reverted to later.

It has been shown that the factors of space-velocity and space-distribution separate the spirals very clearly from the stars of our galaxy; from these facts alone, and from the evidence of the spectroscope, the island universe theory is given a certain measure of credibility.

Another line of evidence has been developed within the past two years, which adds further support to the island-universe theory of the spiral nebulae.

NEW STARS

Within historical times some twenty-seven new stars have suddenly flashed out in the heavens. Some have been of interest only to the astronomer; others, like that of last June, have rivaled *Sirius* in brilliancy. All have shown the same general history, suddenly increasing in light ten thousand-fold or more, and then gradually, but still relatively rapidly, sinking into obscurity again. They are a very interesting class, nor has astronomy as yet been able to give any universally accepted explanation of these anomalous objects. Two of these novae had appeared in spiral nebulae, but this fact had not been weighed at its true value. Within the past two years over a dozen novae have been found in spiral nebulae, all of them very faint, ranging from about the fourteenth to the nineteenth magnitudes at maximum. Their life history, so far as we can tell from such faint objects, appears to be identical with that of the brighter novae. Now the brighter novae of the past, that is, those which have not appeared in spirals, have almost invariably been a galactic phenomenon, located in or close to our Milky Way, and they have very evidently been a part of our own stellar system. The cogency of the argument will, I think, be apparent to all, although the strong analogy is by no means a rigid proof. If twenty-seven novae have appeared in our own galaxy within the past three hundred years, and if about half that number are found within a few years in spiral nebulae far

removed from the galactic plane, the presumption that these spirals are themselves galaxies composed of hundreds of millions of stars is a very probable one.

If, moreover, we make the reasonable assumption that the new stars in the spirals and the new stars in our own galaxy average about the same in size, mass, and absolute brightness, we can form a very good estimate of the probable distance of the spiral nebulae, regarded as island universes. Our galactic novae have averaged about the fifth magnitude. The new stars which have appeared in the spiral nebulae have averaged about the fifteenth magnitude, but it would appear probable that we must inevitably miss the fainter novae in such distant galaxies, and it is perhaps reasonable to assume that the average magnitude of the novae in spirals may be about the eighteenth, or thirteen magnitudes fainter than those in our own galaxy. They would thus be about 160,000 times fainter than our galactic novae, and on the assumption that both types of novae average the same in mass, absolute luminosity, etc., the novae in spirals should be four hundred times further away. We do not know the average distance of the new stars which have appeared in our own galaxy, but 100,000 light-years is perhaps a reasonable estimate. This would indicate a distance of the order of 4,000,000 light-years for the spiral nebulae. This is an enormous distance, but, if these objects are galaxies like our own stellar system, such a distance accords well with their apparent dimensions. Our own galaxy, at a distance of 10,000,000 light-years, would be about 10 minutes of arc in diameter, or the size of the larger spiral nebulae.

On such a theory, a spiral structure for our own galaxy would be probable. Its proportions accord well with the degree of flattening observed in the majority of the spirals. We have very little actual evidence as to a spiral structure for our galaxy; the position of our sun relatively close to the center of figure of the galaxy, and our ignorance of the distances of the remoter stars, renders such evidence very difficult to obtain. A careful study of the configurations and star densities in the Milky Way has led Professor Easton, of Amsterdam, to postulate a spiral structure for our galaxy.

DISTRIBUTION OF SPIRALS

There is still left one outstanding and unexplained problem in the island universe theory or any other theory of the spiral nebulae. Neither theory, as outlined, offers any satisfactory explanation of the remarkable distribution of the spirals. On the older theory, if a feature of our galaxy, what has driven them out to the points most remote from the regions of greatest star density? If, on the other hand, the spirals are island universes, it is against all probability that our own universe should have chanced to be situated about half way between two great groups of island universes, and that not a single object of the class happens to be located in the plane of our Milky Way.

There is one very common characteristic of the spirals which may be tentatively advanced as an explanation of the peculiar grouping of the spirals.

A very considerable proportion of the spirals show indubitable evidence of occulating matter, lying in the plane of the greatest extension of the spiral, generally outside the whorls, but occasionally between the whorls as well. This outer ring of occulting matter is most easily seen when the spiral is so oriented in space as to turn its edge toward us. But the phenomenon is also seen in spirals whose planes make a small, but appreciable angle with our line of sight, manifesting itself in such appearances as "lanes" more prominent on one side of the major axis of the elongated elliptical projection, in a greater brightness of the nebular matter on one side of this major axis, in a fan-shaped nuclear portion, or in various combinations of these effects. The phenomenon is a very common one. Illustrations of seventy-eight spirals showing evidences of occulting matter in their peripheral equatorial regions, with a more detailed discussion of the forms observed, are now being published,[4] and additional examples of the phenomenon are constantly being found.

While we have as yet no definite proof of the existence of such a ring of occulting matter lying in our galactic plane and outside of the great mass of the stars of our galaxy, there is a

[4] Curtis, H. D. *Occulting effects of spiral nebulae.* Univ. Calif. Semi-Cent. Publ. (in press).

great deal of evidence for such occulting matter in smaller areas in our galaxy. Many such dark areas are observed around certain of the diffuse nebulosities, or seen in projection on the background furnished by such nebulosities or the denser portions of the Milky Way; these appearances seem to be actual "dark nebulae."[5] The curious "rifts" in the Milky Way may well be ascribed, at least in part, to such occulting matter.

Though we thereby run the risk of arguing in a circle, the fact that no spirals can be detected in our galactic plane, a natural result of such a ring of occulting matter, would in itself appear to lend some probability to the hypothesis. The peculiar distribution of the spiral nebulae would then be explained as due, not to an actual asymmetrical and improbable distribution in space, but to a cause within our own galaxy, assumed to be a spiral with a peripheral ring of occulting matter similar to that observed in a large proportion of the spirals. The argument that the spirals must be an integral feature of our own galaxy, based on a relationship of avoidance, would then lose its force. The explanation appears to be a possibility, even a strong probability, on the island universe theory, and I known of no other explanation, on any theory, for the observed phenomenon of nebular distribution about our galactic poles.

SUMMARY

The Spiral Nebulae as Island Universes.

1. On this theory, it is unnecessary to attempt to coordinate the tremendous space-velocities of the spirals with the thirty-fold smaller values found for the stars. Very high velocities have been found for the Magellanic Clouds, which may possibly be very irregular spirals, relatively close to our galaxy.

2. There is some evidence for a spiral structure in our own galaxy.

3. The spectrum of the majority of the spirals is practically identical with that given by a star cluster; a spectrum of this general type is such as would be expected from a vast congeries of stars.

[5] BARNARD, E. E. *On the dark markings of the sky,* with a catalogue of 182 such objects. Astrophys. Journ. 49: 1. 1919; CURTIS, H. D. *Dark nebulae.* Publ Astron. Soc. Pacific 30: 65. 1918.

4. If the spirals are separate universes, similar to our galaxy in extent and in number of component stars, we should observe many new stars in the spirals, closely resembling in their life history the twenty-seven novae which have appeared in our own galaxy. Over a dozen such novae in spirals have been found, and it is probable that a systematic program of repetition of nebular photographs will add greatly to this number. A comparison of the average magnitudes of the novae in spirals with those of our own galaxy indicates a distance of the order of 10,000,000 light-years for the spirals. Our own galaxy at this distance would appear 10′ in diameter, the size of the larger spirals.

5. A considerable proportion of the spirals show a peripheral equatorial ring of occulting matter. So many instances of this have been found that it appears to be a general though not universal characteristic of the spirals; the existence of such an outer ring of occulting matter in our own galaxy, regarded as a spiral, would furnish an adequate explanation of the peculiar distribution of the spirals. There is considerable evidence of such occulting matter in our galaxy.

An English physicist has cleverly said that any really good theory brings with it more problems than it removes. It is thus with the island-universe theory. It is impossible to do more than to mention a few of these problems, with no attempt to divine those which may ultimately be presented to us.

While the data are too meager as yet, several attempts have been made to deduce the velocity of our own galaxy within the super-galaxy. It would not be surprising if the space-velocity of our galaxy, like those of the spirals and the Magellanic Clouds, should prove to be very great, hundreds of miles per second.

Further, what are the laws which govern the forms assumed, and under which these spiral whorls are shaped? Are they stable structures; are the component stars moving inward or outward? A beginning has been made by Jeans and other mathematicians on the dynamical problems involved in the structure of the spirals. The field for research is, like our subject matter, practically infinite.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

GEOLOGY.—*Two lamprophyre dikes near Santaquin and Mount Nebo, Utah.* G. F. LOUGHLIN. U. S. Geol. Survey Prof. Paper 120–E. Pp. 9. 1918.

There is no local evidence by which these lamprophyre dikes can be correlated with other igneous rocks. It is assumed that they represent a late stage of the Tertiary volcanic period. The dike rocks are dark gray to black, dense, and porphyritic. Biotite is the only conspicuous megascopic mineral, and constitutes about 20 per cent of the rock. The northern dike has a glassy groundmass crowded with phenocrysts of augite, biotite, olivine, and magnetite, and minute crystals of apatite. The southern dike consists of phenocrysts of biotite, augite, apatite, and magnetite in a groundmass of feldspar. The chemical composition of the northern dike is shown by analysis and compared with rocks of similar composition. The rock is classed as a vitrophyric albite minette. It seems probable that the two minettes discussed are genetically related to a monzonitic magma represented by the latite breccias and flows of the region. R. W. STONE.

GEOLOGY.—*New graphic method for determining the depth and thickness of strata and the projection of dip.* HAROLD S. PALMER. U. S. Geol. Survey Prof. Paper 120–G. Pp. 7. with 3 plates and 5 figures. 1918.

This paper presents three charts by means of which rapid solution of the following problems may be made, namely: (1) to find the depth to a stratum, given the dip and distance from the outcrop; (2) to find the thickness of a bed or series of beds, given the dip and the distance across the outcrop; and (3) to find the inclination of the trace of a plane upon a second plane, given the dip of the first plane and the angle between the strike of the two planes.

Simple directions for the use of the charts are followed by a discussion of the principles and accuracy of the method. H. S. P.

ENTOMOLOGY.—*The question of the phylogenetic origin of termite castes.* CAROLINE BURLING THOMPSON and THOMAS ELLIOTT SNYDER. Biol. Bull. **36**: 115–129, 2 plates, 5 text figs. February, 1919.

The recent observation of one of the authors, that the castes of termites are of germinal origin and not produced by environmental conditions, leads to the question of the phylogenetic origin of these variations or castes. Are termite castes to be considered as fluctuating variations or as mutations?

Several lines of approach lead to this problem; the study of fossil insects; the comparative morphology of termites; exact field observations on termite biology; breeding experiments to determine the type of progeny and the results of hybridization. Although none of these aspects have been exhaustively studied, there are some data, summarized in this paper, drawn from the literature of social insects and from the notes of the two authors.

The morphological facts show that a gradation of characters may be traced throughout the members (castes of a species, *e. g.*, *Reticulitermes flavipes*). These castes might be interpreted either as the gradations in a series of fluctuating variations, or as a series of mutations formed by loss.

Field observations and breeding experiments seem to indicate that although the "first form" reproductive individuals produce young of all the castes, the "second" and "third form" individuals breed true to their own fertile castes. In some breeding experiments in artificial nests, from parent reproductive individuals of the "second form" no fertile individuals of any kind were produced.

The authors intend to undertake a series of studies and experiments upon the morphology and the breeding of the termite castes. C. B. T.

PALEONTOLOGY.—*Appendages of trilobites.* CHARLES D. WALCOTT. Smiths. Misc. Coll. **67**: No. 4, Cambrian Geol. and Pal. IV. 115–216, pls. 14–42, text figs. 1–3. December, 1918.

In this recent paper Dr. Charles D. Walcott summarizes his investigations of the appendages of trilobites during the past forty-five years, a research undertaken in pursuance of a promise made to Professor Louis Agassiz in 1873. Since that time, he writes, "I have examined and studied all the trilobites that were available for evidence bearing on their structure and organization."

His first summary of 1881[1] is reviewed and corrected, together with later papers[2] discussing his various discoveries in this subject. The highly organized trilobite, *Neolenus serratus* (Rominger), from the Burgess shale quarry opened by Dr. Walcott, near Field, British Columbia, several years ago, shows most graphically in the ten plates devoted to its illustration the highly specialized development of appendages, which is also figured in plates of the Ordovician trilobites, *Isotelus*, *Triarthrus*, *Calymene*, and *Ceraurus*. In the figure of *Neolenus* the appendages include antennules, caudal rami, endopodites, epipodites, exopodites, exites, and protopodites. The evidence of appendages is supplemented by numerous figured sections of *Ceraurus* and *Calymene*.

After discussing the mode of occurrence, conditions of preservation, manner of life including methods of progression, food, defense, and offense, the author describes species with appendages, which include besides the genera already mentioned, *Kootenia dawsoni* (Walcott), two species of *Ptychoparia* including a new one, *P. permulta*, from the Burgess shale quarry, *Odontopleura trentonensis* (Hall), *Trinucleus concentricus* Eaton, and an unidentified Ordovician crustacean leg. The work of C. E. Beecher with *Triarthrus* is reviewed in some detail, and a different conclusion arrived at in certain features.

In section 2 of the paper the Structure of the Trilobite receives attention, the author again referring to Beecher and other writers including Jaekel, Beyrich, Barrande, and de Volborth. He then discusses in detail the appendages, summarizing them as follows:

Cephalic: (1) Antennules, (2) Antennae, (3) Mandibles, (4) Maxillula, (5) Maxilla; *Thoracic; Abdominal; Caudal rami.*

Further comparisons are with the recent *Anaspides tasmaniae* G. M. Thomson, a Malacostracan from Tasmania, *Koonunga cursor* Sayce, and *Paranaspides lacustris* Smith, also the parasitic crustacean *Cyamus scammoni* Dall, illustrations of all of which are given. After the extraordinary interest of the finely developed specimens in the plates representing *Neolenus*, attention will be drawn by those of *Isotelus*, *Triarthrus becki* Green, and other Ordovician trilobites, together with

[1] *The trilobite: New and old evidence relating to its organization.* Bull. Mus. Comp. Zool. 8: 191–224, pls. I–VI. 1881.

[2] Proc. Biol. Soc. Washington 20: 94. 1894; Smiths. Misc. Coll. 57: 164–208, pl. 24, figs. 1, 1*a*. 1912; op. cit. pl. 6, figs. 1, 2. 1911; op. cit. pl. 24, figs. 1, 1*a*; pl. 45, figs. 1, 2, 3, 4. 1912; Text-book Pal. (Zittel), Eastman 2d ed. 1: 701, fig. 1343, p. 716, figs. 1376, 1377. 1913; Smiths. Misc. Coll. 57: 149–153. 1912.

the sections of Cambrian and Ordovician trilobites, and finally the author's conclusions as expressed by several diagrammatic restorations, also sketches of thoracic limbs of trilobites and recent crustaceans, crustacean limbs, and six plates of tracks and trails of trilobites, each adding evidence to the author's deductions as to the appendages.

Some conclusions drawn are that the trilobite's appendages show it to have been a marine crustacean far more highly developed than would have seemed possible in a period so infinitely remote. The following are some of the conclusions:

In its younger stages of growth a free moving and swimming animal, it later became a half-burrowing, crawling, and sometimes swimming animal and moving at times with a flow of the tides and prevailing currents.

Eggs have been found both within and free from the body. It was at home on many kinds of sea-bottom and was able to accommodate itself to muddy as well as to clear water.

It was intensely gregarious in some localities and widely scattered in others, depending upon local conditions, and habits of the various species.

Trilobites had an ample system of respiration by setiferous exopodites, epipodites, and exites attached to the cephalic, thoracic, and abdominal limbs, (as shown in restorations of the limbs on plates 34 and 35.)

The structure of the gnathobases of the cephalic limbs indicates soft food such as worms, minute animal life, and decomposed algae. The trilobite persisted from far back in pre-Cambrian time to the close of Carboniferous time. . . and left its remains more or less abundantly through about 75,000 feet of stratified rocks.

The paper is profusely illustrated and carefully indexed

G. R. Brigham.

NAVIGATION.—*The search for instrumental means to enable navigators to observe the altitude of a celestial body when the horizon is not visible.* G. W. Littlehales. Proc. U. S. Naval Inst. **44**: No. 8. August, 1918.

The necessity of seeing the horizon, in order to find the latitude and longitude of a ship at sea, has generally precluded the taking of observations of altitude at night when the number of celestial bodies shining in the firmament is the greatest and would present the most numerous opportunities for determining geographical position if the altitude could be measured without reference to the sea horizon. And even during the daytime navigators are often sensible of this inconvenience on account of the obscuration of the horizon by haze or fog while the luminary continues to be visible.

While adverting to the instances in which the spirit-level or liquid column has been adapted to instruments similar to the sextant, the main object has been to give an account of the evolution of a dynamical artificial horizon for use at sea and, especially, of the gyroscopic horizon designed as an attachment to the frame of the sextant of reflection.

G. W. L.

NAVIGATION.—*Altitude, azimuth, hour angle.* G. W. LITTLEHALES. Proc. U. S. Naval Inst. 43: No. 11. November, 1917.

This paper presents a chart or diagram for finding, by a simple graphic method, hour angle or azimuth at sea. This chart is based upon the function of the angle called the haversine (half versed sine), not generally employed outside nautical circles, and the formula used as a basis is:

$$\mathrm{hav}(a) = \mathrm{hav}(b \sim c) + \mathrm{hav}(b + c) - \mathrm{hav}(b \sim c)\ \mathrm{hav}\ A$$

If the sides, b, c, be regarded as constants, a, A, being variables, this expression takes the form,

$$y = mx + C$$

which is the equation of a straight line.

Based on this, a square chart is given, with sides graduated according to values of a series of natural haversines, by means of which hour angle and azimuth may be found, when the altitude and declination of the body and the latitude of the place are given. By drawing a straight line upon such a chart through two points easily determined, a connection is established between hour angle and zenith distance on the one hand, and between azimuth and polar distance on the other. Hence, with either element of each of these two pairs given, the value of the other may be taken from the chart. The chart itself is 2 feet square and finely graduated so that it may be read with a great degree of accuracy.

The diagram is practical for finding azimuth in sea navigation, and it is possible that in the future it may be adapted so as to be used generally for hour angle purposes as well, especially when the navigation of the air becomes a matter of daily experience. J. F. MEYER.

NAVIGATION.—*The chart as a means of finding geographical position by observations of celestial bodies in aerial and marine navigation.* G. W. LITTLEHALES. Proc. U. S. Naval Inst. 44: No. 3. March, 1918.

Building upon the principle that at any instant of time there is a series of positions on the earth at which a celestial body appears at the same given altitude and that these positions lie in the circumference of a circle marked out by a radius arm whose pivot is that geographical position which has the body in its zenith and whose length is the same arc-measure as the zenith distance or the complement of the altitude the method proceeds to recognize that the difference of the simultaneous altitudes of the same celestial body at two geographical positions is the shortest great circle arc-distance between the circles of equal altitude passing through the two places. By supplying the altitudes and azimuths of the celestial bodies as they would appear at stated intervals of time in a chosen geographical position within the limits of the chart, an observer, in a position as yet unknown, having measured altitude of a celestial body, may at once lay down the locus of his position by comparing the altitude so measured with the tabulated altitude of that body and laying off the difference between the measured and tabulated altitude as an intercept from the chosen geographical position in the direction of the azimuth of the celestial body and toward or away from the bearing of the body according as the measured altitude was higher or lower than the tabulated altitude.

In the illustrative specimen, consisting of a map of the United States, a large compass diagram has been centered at the middle position in latitude 39° and longitude 97°, since the attending tabulation is with reference to this point; and since all altitude-differences are laid off from there, circumferences of equal distances from this point have also been delineated, in order that, with a given altitude-difference, the observer may at once proceed to find the point through which his locus is to be drawn at right angles to the intercept of altitude-difference by passing out by the amount of the altitude-difference to the proper drawn or intermediate circumference along the compass-radial indicated by the azimuth ascertained from the bordering tabulation. G. W. L.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The Board of Managers met on March 24, 1919. The report of the special committee on distribution of the *Proceedings* was adopted, providing for the supplying of certain libraries from the excess stock on hand.

The following persons have become members of the ACADEMY since the last report in the JOURNAL:

Mr. D. DALE CONDIT, U. S. Geological Survey, Washington, D. C.

Professor ERNEST FOX NICHOLS, Yale University, New Haven, Connecticut; and 2022 Columbia Road, Washington, D. C.

Professor ELMER OTTIS WOOTON, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

ROBERT B. SOSMAN, *Corresponding Secretary*.

BIOLOGICAL SOCIETY OF WASHINGTON

The 593d regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, March 8, 1919; called to order at 8.00 p.m. by Vice-President HOLLISTER; 60 persons present.

Three informal communications were presented:

P. BARTSCH: Remarks on a purple finch which had visited the grounds about his dwelling in the city for three successive seasons. This individual bird had peculiar manners which distinguished it from the several other birds with which it was associated. He had seen it pass from immature to adult plumage.

L. O. HOWARD: Remarks on the spread of the European cornborer in Massachusetts and New York.

N. HOLLISTER: Remarks on the ovipositing of an Indian python in the National Zoological Park. It is at present brooding on twelve eggs.

The regular program was a symposium: *What kind of characters distinguish a species from a subdivision of a species.*

The discussion was opened by Prof. A. S. Hitchcock, who explained that, as chairman of the committee on communications, he had arranged to have the subject discussed by the exponents of a few of the larger

groups of organisms. It had been impracticable to include a discussion of the very interesting categories, known as physiological species or races, such as the parasitic fungi, among which are races that appear identical morphologically but which are confined to certain host plants, each to each, or such as the bacteria, many forms of which appear identical morphologically but which cause distinct physiological effects, either chemically on artificial substrata, or biologically in producing diverse diseases of plants and animals. Mr. Hitchcock further stated that much of our difficulty in determining whether a given form represents a species or a subdivision of a species results from our ignorance. We do not have sufficient facts. If we are compelled to draw conclusions from a single specimen in a herbarium or even from several specimens we can give only an opinion as to the relation of this form to others, an opinion strengthened, it is true, by training and experience, but at best only an opinion. If we have all the facts, or enough so that lacking data may be safely ignored, our problem is to interpret results and define relations.

Mr. N. Hollister said: Nearly all systematic mammalogists now distinguish subspecies from species by the test of intergradation: some workers insist upon an actual blending of characters over continuous range between typical subspecies, while others admit what is known as "intergradation of characters," even between insular forms, to be sufficient reason for the use of the trinomial. Old conceptions of what is a species are now lightly considered, and authors are frequently inconsistent in their treatment of forms. A good definition of a species was given a few years ago by one writer who stated that "a species is a thing described as such." The same kinds of characters, or precisely the same character, may serve in different instances for distinguishing subspecies, species, or even genera. The difference in the number of the enamel folds in the last upper molars of the capybaras of Surinam and Paraguay was cited as a case where a character sometimes of generic weight serves only to separate subspecies. Specimens showing the process of the loss of one fold are found in Brazil midway between the two typical races. It is a common experience for the monographer working with material assembled from many collections to reduce numerous described species to the rank of subspecies; the forms so treated still retain exactly the same characters that served them as full species.

Dr. H. C. Oberholser spoke on the question from the standpoint of an ornithologist. He said: Most ornithologists at the present time regard the distinction between a species and a subspecies as one of the presence or absence of intergradation. In other words, a subspecies is an imperfectly segregated species—a form occupying a separate geographic area and intergrading with some other form. This intergradation may take place: (1) by gradual change over contiguous geographic areas; (2) by an abrupt change in an intermediate area; (3) by individual variation, whether or not the ranges of the two forms adjoin. The amount of difference does not constitute the distinction

between a species and a subspecies, because even very closely allied forms are species, if their characters are trenchant and the birds do not freely interbreed; while, on the other hand, however great the differences may be between two forms, they are to be regarded as subspecies if intergradation exists.

Dr. N. C. KENDALL's remarks were published in a recent number of this JOURNAL (9: 187. 1919).

Dr. P. BARTSCH speaking on the question with respect to mollusks said: There are no hard and fast lines that can be invariably employed in deciding to which nomenclatorial category a certain form should be assigned. He thought that in the present imperfect state of our knowledge, most designations were largely a matter of judgment and expediency. Systematists at present unfortunately recognize only two categories, species and subspecies, by means of which they attempt to designate all the products of Nature's laboratories. This makes all sorts of compromises necessary in order to squeeze a given form into the one or the other of the two. It is his firm belief that when the work of experimental biologists and breeders, which is heaping up a pile of data, will have advanced a little further, we shall be furnished with a mass of information which will demand recognit on of a larger series of categories designed to express the true inwardness of phylogenetic relationship a little more definitely than it is expressed by our present system of nomenclature.

In many instances it is not difficult to decide the status of a form. The old definition that "A species embraces an aggregation of individuals which may differ in age, sexual, seasonal or individual characteristics" is easily enough applied in many instances; likewise can be applied the definition for the subspecies, which simply makes it necessary to have connecting elements between two such groups, but what shall be done with a case like the following?

"In the Philippine Islands we have, as far as known, only a single species of *Vivipara* in a given region. In Lake Lanao, on the other hand, we have apparently about forty. At all events there seem to be that many constant forms, for the young which I have extracted from probably more than a thousand individuals have always agreed with the parents in sculptural characters. The range of form modifications in these Lake Lanao viviparas can best be seen by consulting my papers on the group.[1] Another paper on this topic is almost completed. This is based on an examination of about 3,000 specimens. What designation shall be given to forms like these? These are probably the result of cross breeding between two distinctly related stalks of the genus. At least my Cerion breeding experiments would indicate this.

[1] *The Philippine pond snails of the genus Vivipara.* Proc. U. S. Nat. Mus. 32: 135–150. pls. 10 and 11. 1907; *Notes on the Philippine pond snails of the genus Vivipara, with descriptions of new species.* Proc. U. S. Nat. Mus. 37: 365–367. 1909.

Sometimes I have deliberately used a trinomial when the data at hand really indicated a binomial. Let me explain by an example. The genus *Leptopoma* has probably twenty phylogenetic stalks or super-species in the Philippine Archipelago. Some of these groups have in the past been considered a single widely distributed very variable species. The abundant material which is rapidly accumulating in the U. S. National Museum proves conclusively that every island has its distinct form, and the larger islands, where faunal barriers exist, may have two or more. In some cases, intergradations exist, while in others they do not. Now the rule would say, designate the distinct forms as species and those with intergrades as subspecies, but how much more rational to consider the entire complex under one specific, name and the various races under a trinomial—at least for the present until material from the entire range showing all possible phases of these groups will have been examined, for by so doing one has the advantage of knowing at once that the organism in question is the *Leptopoma nitidum* representative of Luzon, or a member of the *Leptopoma goniostoma* group."

Mr. A. N. Caudell as an entomologist said: In his work on the Orthoptera he recognized two grades below the species, that is the geographical race, or subspecies, and the variety. He gave the following definitions:

Species. A group of individuals separable from allied groups by appreciable external morphological characters of a sufficiently stabilized nature to prohibit a general mergence through variation, based on a biological foundation sufficiently firm to assure breeding true to nature, and the production of fertile progeny.

Geographical race. An assemblage of individuals of a species distinguishable from each other, and from the dominant form, by appreciable external morphological characters and occupying different, but adjacent, geographical regions, at the junction of which complete mergence through variation occurs. In other words, races are incipient species originating through variation caused by diverse environmental conditions due to geographical distribution.

Variety. Individuals of a species or of a race varying more or less from the typical in external morphological or colorational characters, not with relation to geographical distribution and subject to complete integration through variation.

Each of these groups was briefly discussed and emphasis was given the fact of this being the present personal opinion of the speaker and not intended in any way to represent the views of entomologists in general. It was admitted that for use in a broader way, especially in higher zoological groups, the definition of species should be broadened to include physiological characters, and also, probably, biological features.

Dr. S. F. Blake discussed the question from the botanical aspect: A subspecies in botany, as in zoology, is ordinarily distinguished from a species by the fact that it intergrades with a related form or forms,

while a species does not. Two kinds of intergradation must be distinguished, that due to fluctuating variation, which indicates subspecific rank, and that due to hybridism, which may occur between species. As most systematic work is done with herbarium specimens, it is not possible to distinguish these by breeding tests, and their discrimination is a matter of judgment and experience. Furthermore, the absence of intergradation is not in itself a criterion of specific rank. Many unit-character forms, very distinct in appearance, such as albinos or forms with peculiar leaves, will not be found to intergrade, and they even have rather distinct geographical ranges. In such cases the rank to be given the form in question depends on the extent of the botanist's field experience. In general, forms distinguished by several constant characters are species; forms distinguished by only one or by inconstant characters, subspecies; but there is no absolute test which can be applied, and in doubtful cases the decision depends on the experience and point of view of the botanist.

Each of the above speakers was limited to ten minutes for the presentation of his remarks. After the formal remarks a general discussion ensued in which Messrs. A. S. Hitchcock, A. N. Caudell, P. Bartsch, N. Hollister, S. A. Rohwer, L. O. Howard, V. Bailey, and M. W. Lyon, Jr., took part.

M. W. Lyon, Jr., *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

An executive order by the President, dated February 26, 1919, transfers twenty-three former officers of the U. S. Coast and Geodetic Survey from the War Department back to the jurisdiction of the Survey; and forty-six officers, similarly, from the Navy Department to the Survey. Five Survey vessels are also returned. The transfers are to become effective before April 1, 1919.

The Bureau of Mines has sent a special mission to Europe to collect information on the methods discussed and those adopted in the rebuilding of the mining and metallurgical plants and industries in the devastated areas. The members of the mission are: F. G. COTTRELL, chief metallurgist; G. S. RICE, chief mining engineer; W. PERDUE, petroleum technologist; and F. K. PROBERT of the University of California, consulting mining engineer. The mission will have headquarters in London.

Messrs. HOYT S. GALE and J. B. UMPLEBY, of the U. S. Geological Survey, have gone to France to investigate certain questions of mineral resources, particularly potash salts, involved in the peace negotiations.

Dr. OLAF ANDERSEN, of the Mineralogical Institute, Kristiania, Norway, visited Washington in March.

Lieut. Col. W. D. BANCROFT, of the Chemical Warfare Service, has been elected Chairman of the Division of Chemistry and Chemical Technology of the National Research Council.

Dr. W. N. BERG, formerly captain in the Sanitary Corps, and stationed at Camp Lee, received his honorable discharge from the Army in March and has returned to the Bureau of Animal Industry.

Major CHARLES HARROD BOYD, for forty years an officer of the Coast and Geodetic Survey, died on February 9, 1919, at his home in Portland, Maine, in his eighty-sixth year. He entered the Survey in 1855, served with the Port Royal expedition in 1861, and served under Gen. Barnard on the fortifications near Washington later in the war, retiring from the Survey in 1894.

Dr. H. L. CURTIS, of the Bureau of Standards, has gone for a three months visit to European laboratories to obtain data on the progress of certain war problems.

Dr. ALFRED C. HAWKINS, recently appointed crystallographer in the laboratories of E. I. du Pont de Nemours and Company, is spending a few weeks in studying recent advances in this subject at the Bureau of Chemistry and other Washington laboratories.

Capt. P. E. Landolt of the Nitrate Division, Army Ordnance, has resigned from the service and has returned to his work as chemical engineer with the Research Corporation at New York City.

Dr. A. O. Leuschner, who has been with the National Research Council since November, 1918, returned to the University of California in the latter part of March.

Mr. James W. McGuire, of the Coast and Geodetic Survey, has been appointed a member of the U. S. Geographic Board.

Lieut. Col. William McPherson, Chemical Warfare Service, Professor of Chemistry at the Ohio State University, Columbus, Ohio, who was stationed in Washington in the early part of the war and was later sent to France, received his honorable discharge from the Army in March, and has returned to the University.

Dr. W. B. Meldrum, professor of chemistry at Haverford College, and until lately a member of the Chemical Warfare Service and of the price section of the War Trade Board, has received a temporary appointment as assistant physical chemist at the Geophysical Laboratory, Carnegie Institution of Washington.

Professor Sem Saeland, Professor of Physics and Rektor of the Technological Institute of Norway, at Trondhjem, Norway, visited Washington in March.

Dr. H. C. Taylor, head of the department of agricultural economics in the College of Agriculture, University of Wisconsin, has been appointed Chief of the Office of Farm Management, Department of Agriculture.

Col. W. H. Wilmer, Medical Corps, U. S. A., returned to Washington on March 22. He expects to continue in the Army for a period to write the history of the laboratory work of the Air Service in France.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 9 MAY 4, 1919 No. 9

BOTANY.—*Revision of Ichthyomethia, a genus of plants used for poisoning fish.* S. F. BLAKE, Bureau of Plant Industry.

The genus Ichthyomethia, belonging to the tribe Dalbergieae of the family Fabaceae, is of economic importance among the aborigines of tropical America as one of the plants commonly used as a fish poison. Its use for this purpose in Jamaica, where it is called dogwood, was so well described by Patrick Browne[1] that it is only necessary to cite his quaint account.

> The bark of the root of this tree is used for the same purposes, and with the same effects, as the leaves and branches of Surinam poison, already described: it is pounded, and mixed with the water in some deep and convenient part of the river, or creek, etc., from whence it may spread itself more diffusively around, and in a few minutes after it is well mingled, you'll see the fish, that lay hitherto hid under the neighboring rocks, or banks, rising to the surface, where they float as if they were dead; in which situation they continue for a considerable time; but most of the large ones that are left, recover after a time; while the smaller fry are all destroyed, and float upon the surface, for some days after. The eel is the only fish I have observed, that could not be intoxicated with the common doses of this bark, though it affects it very sensibly; for the moment the particles spread where it lies, it moves off, and swims with great agility through the water. I have sometimes seen them chased to and fro, in this manner, for some minutes, without being any ways altered.
>
> The tree is generally considered as one of the best timber-trees in the island. The wood is very hard, and resinous; and lasts almost equally in or out of water. It is of light brown color, coarse, cross-grained, and heavy.

The bark of the roots of the genus has found some application in eclectic medicine, under the name Piscidia or Piscidia bark,

[1] Nat. Hist. Jam. 296. 1756.

but it is not listed in the United States Dispensatory. The active principle, according to Hart as quoted by Felter and Lloyd,[2] is a neutral body, piscidin ($C_{29}H_{24}O_8$), which has narcotic and analgesic properties. It has been used for alleviating insomnia and neuralgia, for allaying spasms, and for similar purposes. Experimentally it has been found to bring about death in animals by causing heart failure or by arresting respiratory action.

Although this genus has generally been known under the name Piscidia, given it by Linnaeus in 1759, it is necessary under the American Code of Botanical Nomenclature to adopt for it the name Ichthyomethia, published by Patrick Browne in 1756, with a reference to the original species, *Erythrina piscipula* L.

In addition to the original species, *Ichthyomethia piscipula* (L.) Hitchc. (*Erythrina piscipula* L., 1753; *Piscidia erythrina* L., 1759), and some species wrongly ascribed to the genus by early authors, four species have been described: *Piscidia Americana* Moc. Sessé, *P. mollis* Rose, *P. cubensis* Urban, and *Ichthyomethia havanensis* Britton & Wilson. A sixth species is *Derris grandifolia* Donn. Smith, the fruit of which, unknown to the describer of the species, shows it to be a member of this genus. In addition to these species, study of the specimens in the National Herbarium, supplemented by material from the New York Botanical Garden and the Gray Herbarium, has shown the existence of three new species, closely related to *I. piscipula* but distinguished by constant characters and definite geographical ranges. My thanks are due to the curators of the herbaria mentioned for the loan of the material.

Of the eight species here recognized, three (*I. grandifolia*, *I. mollis*, and *I. cubensis*) are very distinct in characters of foliage and pubescence. The other five form a closely related group centering around the original species, *I. piscipula*. In making out the characters which distinguish these species, and in correlating them with distribution in definite floristic regions, I am indebted for advice and assistance to Mr. William R. Maxon. The first of these, *I. piscipula*, definitely known as a native only

[2] King's Amer. Dispensatory ed. XI. (3d revision) 2: 1510. 1900.

of Jamaica, is distinguished by having the leaves evenly but not densely short-pilose beneath with spreading-ascending, usually rufescent hairs, while in the other four species they are merely puberulous to strigose. In two of these, *I. havanensis* and *I. communis*, the leaves are densely puberulous beneath with incurved or ascending hairs, which are more numerous along the veins and veinlets and coincide with them in direction. In the remaining two species, *I. americana* and *I. acuminata*, the leaves are distinctly strigose or strigillose beneath, and the hairs, except along the costa and the primary lateral veins, do not follow the direction of the nervation, but all point toward the margin of the leaf; in consequence of which the hairs which arise from the secondary and tertiary veinlets diverge from their veinlets at approximately a right angle, and those which arise from the surface below and near the veinlets lie across the latter transversely. Associated with these characters of pubescence is a difference in the ceraceous covering of the under leaf surface. In *I. communis* the waxy covering is comparatively thick and is divided by the ultimate veinlets into definitely raised areoles. In most of the other species it is thinner and flatter and, owing to the weaker development of the veinlets, does not have the same areolate appearance.

Piscidia carthagenensis, Jacq.,[3] briefly described by Jacquin from fruiting material collected at Cartagena, was said to differ from *P. erythrina* L. in its obovate, much larger leaflets. No material from Colombia has been seen by the writer, and Jacquin's account is so incomplete that is it necessary for the present to leave the identity of the species in doubt. It is presumably most closely related to *I. acuminata*, and may prove to be identical. DeCandolle's account of *P. carthagenensis* in the Prodromus[4] evidently applies in part to *Ichthyomethia piscipula* and perhaps to other species not then distinguished.

Loefling's *Piscipula erythrina*,[5] incompletely described from trees found by Loefling in northeastern Venezuela, is perhaps

[3] Enum Pl. Carib. 27. 1760; Stirp. Amer. 210. 1763.

[4] Prodr. 2: 267. 1825.

[5] It. Hisp. 275. 1758.

identical with Jacquin's *P. carthagenensis*. As Loefling gives no account of the pubescence of the leaves, it is impossible in the absence of specimens to be certain of the identity of his plant.

The only South American material of the genus in the herbaria which the writer has examined consists of fruits in the National Herbarium collected at Río Macara, Ecuador, altitude 455 to 610 meters, April, 1910, by C. H. T. Townsend (no. 849), and leaves in the Gray Herbarium collected on Chatham Island, Galápagos Islands, 1899, by Snodgrass and Heller (no. 503). Both these collections are too imperfect for specific determination.

Ichthyomethia P. Br. Nat. Hist. Jam. 296. 1756.

Piscipula Loefl. It. Hisp. 275. 1758.
Piscidia L. Syst. ed. 10. 1155. 1759.

Trees or shrubs, not climbing; leaves odd-pinnate, the leaflets opposite; flowers in lateral panicles, appearing before the leaves; calyx campanulate, obscurely 2-lipped, the upper lip emarginate, the lower 3-lobed, the teeth deltoid; flowers rosy or white and red, rarely yellowish white, vexillum suborbicular or oval-obovate, emarginate, short-clawed; wings falcate-oblong, long-clawed, adherent to keel near middle, the limb auriculate above at base; keel obtuse, its petals long-clawed, their limbs united near middle for about one-third their length, auriculate-sagittate on upper side at base; stamens 10, the vexillar one free at base for one-quarter to one-half its length, or rarely free throughout; ovary sessile, many-ovulate; style filiform, incurved, glabrous, with a small terminal stigma; legume indehiscent, firm, with linear body, broadly or narrowly 2-winged on each suture, stipitate, 1 to 6-seeded, in age tending to break transversely between the seeds.

Type species, *Erythrina piscipula* L.

KEY TO SPECIES

Wings as broad as or much broader than the body of the fruit; leaflets 3 to 12 cm. long.
 Leaves very densely and softly cinereous-tomentulose or pilose beneath; vexillum glabrous (so far as known); vexillar stamen entirely free (so far as known).
  Leaves densely tomentulose beneath........1. *I. grandifolia*.
  Leaves densely short-pilose beneath.............2. *I. mollis*.
 Leaves puberulous, strigose, or short-pilose beneath; vexillum densely pubescent; vexillar stamen free for one-fourth to one-half its length.
  Leaves puberulous to strigose beneath.
   Leaves densely incurved-puberulous or ascending-puberulous beneath, the hairs more numerous along the veinlets and parallel with them; stipe of fruit equaling or slightly exceeding the calyx.

Low shrub; petiole and rachis spreading-puberulous; leaflet prominulous-reticulate beneath; fruit 1.2 to 3.5 cm. long ....3. *I. havanensis.*

Tree; petiole and rachis strigillose or appressed-puberul ous; leaflets not prominulous-reticulate beneath; fruit 2.5 to 7.5 cm. long..............................4. *I. communis.*

Leaves strigose or strigillose beneath, the hairs not more numerous along the veinlets, crossing them transversely; stipe of fruit much exceeding the calyx.

Lobes of lower lip of calyx obtuse or rounded.......... ....5. *I. americana.*

Lobes of lower lip of calyx short-acuminate................ ....6. *I. acuminata.*

Leaves short-pilose beneath with spreading-ascending hairs..............................7. *I. piscipula.*

Wings much narrower than the body of the fruit; leaflets 1 to 2 cm. long.....................................8. *I. cubensis.*

1. **Ichthyomethia grandifolia** (Donn. Smith) Blake.

Derris grandifolia Donn. Smith, Bot. Gaz. **56:** 55. 1913.

Tree, with stout branches; shoots of the year cinereous-tomentulose, the older branches glabrate; leaves 7 to 11-foliolate, 18 to 33 cm. long; petiole, rachis, and petiolules densely cinereous- or sordid-tomentulose with crisped spreading hairs; leaflets 5.5 to 10 cm. long, 3 to 6.5 cm. wide, oval or the lowest ovate, broadly rounded, mucronulate, rounded at base, thick, above dull green, densely crisped-pilosulous, beneath densely cinereous-tomentulose with crisped spreading hairs, these in youth concealing the secondary veins; panicles cylindric, dense, 10 to 15 cm. long, sordid-tomentulose; pedicels 1.5 to 4.5 mm. long; calyx 7 to 8 mm. long, densely sordid-pilosulous, the lobes of lower lip deltoid-triangular, short-acuminate; vexillum oval-obovate, glabrous, 10 mm. long; alae 12 mm. long (the claws 5.5 mm. long), the limb ciliate on lower edge toward base; keel 13.5 mm. long, glabrous; vexillar stamen entirely free; fruit 4 to 9 cm. long, 2.5 to 5 cm. wide, 3 to 5-seeded, densely sordid-pilosulous, the wings usually not divided, as broad as or broader than the body, the stipe exceeding the calyx by 1 to 3 mm.

TYPE LOCALITY: Cerro Gordo, Guatemala.

SPECIMENS EXAMINED:

PUEBLA: Zapotitlán, 1908, *Purpus* "= 2648."

OAXACA: Near Dominguillo, altitude 1370 to 1675 meters, 1894, *Nelson* 1826.

GUATEMALA: Volcán Imay, Dept. Jalapa, altitude 1525 meters, 1908, *Kellerman* 8048 (N. Y. Bot. Gard.). Cerro Gordo, Dept. Santa Rosa, altitude 1100 meters, August, 1892, *Heyde & Lux* 3709 (type collection).

This species departs from other members of the genus in its glabrous banner and its free vexillar stamen. The flowers of the next species,

I. mollis, have not yet been collected, but from the agreement in other features it is probable that they will show the same peculiarities. The fruit of both species is precisely that of the type species of Ichthyomethia, and the character of the stamens is known to vary in the same way in related genera of this group.

2. **Ichthyomethia mollis** (Rose) Blake.

Piscidia mollis Rose, Contr. U. S. Nat. Herb. 1: 98. 1891.

Tree, 3 to 8 meters high; branches rather slender, softly cinereous-tomentulose, in age glabrate; leaves 7 to 13-foliolate, 8 to 20 cm. long; petiole, rachis, and petiolules densely cinereous-tomentulose; leaflets 3 to 7.8 cm. long, 2 to 4 cm. wide, oval to ovate, acute to rounded, at base rounded, whitish green on both sides, above densely pilosulous with crisped hairs, beneath densely and softly short-pilose with ascending hairs, in age prominulous-reticulate; fruit 2.5 to 5 cm. long, 3.5 to 4.5 cm. wide, 1 to 3-seeded, densely cinereous-puberulous, the wings much wider than the body of the fruit, sometimes split in age.

TYPE LOCALITY: Ridges about Alamos, Sonora.

SPECIMENS EXAMINED:

SONORA: Alamos, 1890, *Palmer* 355 (type collection). Dry hills, Alamos, 1910, *Rose, Standley, & Russell* 12906, 13515. Near Torres, 1903, *Coville* 1659.

This species is distinguished from *I. grandifolia* by having its leaflets pilose rather than tomentose beneath. The flowers have not yet been collected. The plant bears the vernacular name "palo blanco." One of the specimens collected by Rose, Standley, and Russell, under their number 12906, is remarkable in having dull green, rather sparsely pilosulous leaves. It is doubtless a sucker growth or young shoot of the plant, and is not properly to be taken as indicating variation in the adult leaves, all those examined being very constant in both color and pubescence.

3. **Ichthyomethia havanensis** Britton & Wilson, Bull. Torrey Club **44**: 34. 1917.

Shrub, 2 meters high; branchlets sparsely puberulous, in age fuscous, glabrate; leaves 9-foliolate, 10 cm. long; petiole and rachis rather densely sordid-puberulous with spreading hairs; leaflets (immature) 3.5 cm. long, 1.5 cm. wide, elliptic to oblong-oval, obtuse to rounded, mucronulate, at base cuneate-rounded, above dull green, spreading-puberulous, glabrescent, beneath paler, prominulous-reticulate, densely puberulous with ascending hairs somewhat more numerous along the veins; calyx 5 mm. long, densely rufescent-strigillose, the teeth deltoid, obtuse; fruit, 1.2 to 3.5 cm. long, 2 to 2.8 cm. wide, 1 to 3-seeded, appressed-puberulous, the wings much wider than the body, usually undulate-divided.

TYPE LOCALITY: Near Cojimar, Havana, Cuba.
SPECIMENS EXAMINED:

CUBA: Thickets not far from Cojimar, May 14, 1915, *León & Roca* 6194 (type; N. Y. Bot. Gard.).

This species, of which only the type, in fruit and young leaf, has been examined, is distinguished from the next by its smaller fruit and smaller leaflets, these prominulous-reticulate beneath, as well as by the pubescence of the rachis and petiolules.

4. **Ichthyomethia communis** Blake, sp. nov.

Tree, 20 meters high or less; branchlets strigillose, soon glabrate; leaves 7 or 9-foliolate, 12 to 22 cm. long; petiole and rachis sordid-strigillose or appressed-puberulous, sometimes glabrate in age; leaflets 4 to 12 cm. long, 2 to 5 cm. wide, oblong or elliptic to obovate-oval, acute or short-pointed, rounded to cuneate at base, above green, appressed-puberulous, at length glabrate, beneath pale, not prominulous-reticulate, densely incurved-puberulous, the hairs more numerous along the veins; panicles 3 to 9 cm. long, many-flowered, often branched from base, finely griseous-puberulous; pedicels 2 to 6 mm. long; calyx 4.5 mm. long, densely cinereous-puberulous; the teeth of lower lip broadly deltoid, obtuse or rounded; vexillum 12.5 mm. long, suborbicular, densely cinereous-pubescent on back; alae about 15 mm. long (the claws 7 mm. long), the lamina sparsely pubescent; keel 12 mm. long (the claws 6.5 mm. long), the petals pubescent below, the claws ciliate beneath above the middle; vexillar stamen free for one-fourth to one-half its length; fruit 2.5 to 7.5 cm. long, 2.8 to 4 cm. wide, 1 to 6-seeded, cinereous-puberulous, especially on the body, the wings much wider than the body, usually undulate-divided, the stipe equaling the calyx or exceeding it by only 6 (rarely 9) mm.

Type in the U. S. National Herbarium, no. 41958, collected in forests on coral soil, Ramrod Key (flowers), and on Jewfish Key, Florida (leaves and fruit), May and July, by A. H. Curtiss (no. 685).

OTHER SPECIMENS EXAMINED:

FLORIDA: Miami, 1877, *Garber*. Punta Rassa, Lee County, 1900, *Hitchcock* 76; 1916, *Miss J. P. Standley* 257. Marco, Lee County, 1916, *P. C. Standley* 12732. White Horse Key, and Key West, 1891, *Simpson* 234. Palm Cape, *Chapman* 34.

TAMAULIPAS: Tampico, 1910, *Palmer* 510.

SAN LUIS POTOSÍ: Limestone hills, Rascón, 1892, *Pringle* 4110.

VERACRUZ: Pueblo Viejo, near Tampico, 1910, *Palmer* 541 (N. Y. Bot. Gard.).

YUCATÁN: Mérida, 1865, *Schott* 260. Sisal, 1916, *Gaumer & Sons* 23219. Without definite locality, 1895, *Gaumer* 524.

HONDURAS: Ruatan Island, 1886, *Gaumer* 154.

CUBA: Manzanillo, 1912, *Shafer* 12349. Ensenada de Mora, Oriente, 1912, *Britton, Cowell, & Shafer* 12926 (N. Y. Bot. Gard.).

This species, the commonest and most widely distributed of the genus, has not previosuly been distinguished from *I. piscipula*. It is readily separated, however, by the leaves, which in *I. communis* are densely incurved-puberulous beneath, with the hairs along even the ultimate veinlets parallel to the latter. In *I. piscipula* the leaves are short-pilose with spreading-ascending hairs beneath, and the hairs along the veinlets do not coincide with them in direction but lie across them transversely.

I. communis is called "haabí" by the Mayas of Yucatán, and "chijol" by the Huastecan Indians of Tamaulipas and Veracruz.

5. **Ichthyomethia americana** (Moc. & Sessé) Blake.

Piscidia americana Moc. & Sessé, Pl. Nov. Hisp. 116. 1887.

Tree; branchlets appressed-puberulous, soon glabrate; leaves 9 to 13-foliolate, 12 to 20 cm. long; petiole and rachis appressed-pubescent, glabrescent, leaflets 4 to 8 cm. long, 1.7 to 4 cm. wide, oval-oblong or elliptic-oblong or the terminal one obovate-oval, rounded or obtuse, sometimes acute, rounded at base, pergamentaceous, above light green, glabrous, beneath pale, evenly but not densely short-strigose, the hairs on the costa and primary veins appressed to them, those on the secondary and tertiary veinlets and on the surface directed toward margin of leaf, thus crossing the veinlets nearly at a right angle, and not more numerous along than between them; panicles 8 to 24 cm. long, strigillose; pedicels 2 to 7 mm. long; calyx 6 to 7 mm. long, cinereous-puberulous with appressed hairs, the lobes of lower lip deltoid-ovate or broadly deltoid, slightly overlapping near base, obtuse or rounded, rarely acutish at tip; vexillum 15 mm. long, densely cinereous-puberulous dorsally, in youth subsericeous; alae 15.5 mm. long (the claws 7 mm. long), the laminae sparsely puberulous toward base; keel 15 mm. long (the claws 7 mm. long), the petals puberulous below; vexillar stamen free for one-third its length; fruit 1.5 to 7.5 cm. long, 1.8 to 4.3 cm. wide, 1 to 6-seeded, appressed-puberulous, the glabrescent wings much wider than the body, often undulate-divided, the stipe exceeding the calyx by 6 to 12 mm.

TYPE LOCALITY: Apatzingan, Michoacán, Mexico.

SPECIMENS EXAMINED:

MICHOACÁN: Hacienda Guadalupe, near Río Balsas, 1903, *Nelson* 6969. Nusco (Michoacán or Guerrero), 1899, *Langlassé* 936.

GUERRERO: La Junta, 1903, *Nelson* 6991.

GUATEMALA: Naranjo, altitude 90 meters, 1892, *J. D. Smith* 2815.

This species is called "tatzungo" or "zatzumbo" by the Tarascan Indians of Michoacán, according to Mociño and Sessé. In Guerrero it is known by the native name "cocuile" and the Mexican names "colorín de peces" and "matapez." Although there is little in the description

of Mociño and Sessé to differentiate this species, its identity is clear from the locality.

6. Ichthyomethia acuminata Blake, sp. nov.

Tree; branchlets strigillose, soon glabrate; leaves 7 to 11-foliolate, 17 to 30 cm. long; petiole and rachis strigillose, glabrescent; leaflets 4 to 13 cm. long, 2.2 to 7 cm. wide, oval to ovate-oval, or the terminal one obovate-oval or rarely suborbicular, obtuse or rounded, rarely short-pointed, rounded at base, pergamentaceous, above light or dark green, glabrous or essentially so, beneath paler, evenly but not densely strigose or strigillose, the hairs lying across the prominulous secondary and tertiary veins and not more numerous along them than between them; panicles 10 to 30 cm. long, strigillose; pedicels 4 to 8 mm. long; calyx 5 to 6 mm. long, densely cinereous-strigillose, the lobes of lower lip deltoid, acute or acuminate; flowers "pink;" vexillum 13 to 15 mm. long, densely cinereous-strigose dorsally, in youth subsericeous; alae 15 to 18 mm. long (the claws 6.5 to 8 mm. long), the laminae sparsely pubescent; keel 14 mm. long (the claws 6 mm. long), the petals pubescent below, the claws ciliate below above the middle; vexillar stamen free for one-quarter to one-half its length; fruit 2 to 8.5 cm. long, 2.5 to 4 cm. wide, 1 to 5-seeded, strigillose, the wings much wider than the body, often undulate-divided, the stipe exceeding the calyx by 8 to 13 mm.

Type in the U. S. National Herbarium, no. 639557, collected in Antigua, Lesser Antilles, February 4–16, 1913, by J. N. Rose, W. R. Fitch, and P. G. Russell (no. 3419).

OTHER SPECIMENS EXAMINED:

PORTO RICO: Playa de Fajardo, 1913, *Britton & Shafer* 1575. Punta Guaniquilla, 1915, *Britton, Cowell, & Brown* 4576.

CULEBRA: Culebra, 1906, *Britton & Wheeler* 62.

VIEQUES ISLAND: Punta Arenas to Boca Quebrada, 1914, *Shafer* 2912.

TORTOLA: Road Town to Sea Cow Bay, 1913, *Britton & Shafer* 684.

ST. CROIX: Christiansted, 1913, *Rose, Fitch, & Russell* 3579. Without definite locality, 1896, *Ricksecker* 320.

ST. JAN: Bethania, 1913, *Britton & Shafer* 336.

MONTSERRAT: Without definite locality, 1907, *Shafer* 462.

GUADELOUPE: Without definite locality, altitude 250 meters or less, 1892, *Duss* 2662.

BARBADOS: Dover or Constitution Hill, Farley Hill, 1895, *Waby* 83.

TOBAGO: Scarborough, 1914, *Broadway* 4808.

This species and the preceding (*I. americana*) are distinguished from the other species of the *I. piscipula* type by the character of their pubescence and by the long stipe of the fruit. They are distinguished from one another chiefly by the shape of the lower calyx lobes, which are acute or short-acuminate in the present plant and taper from the

base, while in *I. americana* they are obtuse or rounded, or rarely slightly acutish at the extreme tip.

I. acuminata is known as "bois énivrant" and "bois à énivrer" in the French Islands of the Lesser Antilles, and as "ventura" in Porto Rico.

7. **Ichthyomethia piscipula** (L.) Hitchc.; Sarg. Gard. & For. **4:** 472. Oct. 1891.[6]

Erythrina piscipula L. Sp. Pl. **2:** 707. 1753.
Piscidia erythrina L. Syst. ed. X. 1155. 1759.
"*Piscidia inebrians* Medic. Vorles. Churpf. Phys. Ges. **2:** 394. 1787."
"*Piscidia toxicaria* Salisb. Prodr. 336. 1796."
Piscidia piscipula Sarg. Gard. & For. **4:** 436. 1891.

Tree, 12 meters high or less; branchlets rufescent-strigillose, glabrate; leaves 7-foliolate, 22 to 26 cm. long; petiole and rachis rufescent-strigose or strigillose; leaflets 5.5 to 11.5 cm. long, 4.5 to 7 cm. wide, oval or obovate-oval, rounded or short-pointed, at base rounded to slightly cordate, pergamentaceous, above deep green, strigillose-puberulous, glabrate, beneath slightly paler, prominulous-reticulate, rather densely short-pilose with spreading-ascending, usually somewhat rufescent hairs, these somewhat more numerous and more or less appressed along the costa and primary veins, those along the veinlets crossing them transversely and not more numerous than on the surface between them; panicles numerous, 5 to 16 cm. long, strigillose, much branched; pedicels 4 to 7 mm. long; calyx 5.5 to 6 mm. long, densely cinereous-strigillose, the lobes of lower lip deltoid, the lateral ones broadly rounded or obtuse, the middle one acute or acutish; corolla rosy or "white and red;" vexillum 13 mm. long, densely strigillose dorsally, in youth subsericeous; alae 13.5 mm. long (the claws 6 mm. long), the lamina sparsely pubescent along midline; keel 12 mm. long (the claws 5.5 mm. long), the petals pubescent and short-ciliate below, their claws short-ciliate below above the middle; vexillar stamen free for one-fourth its length; fruit 2.5 to 7 cm. long, 2.5 to 4 cm. wide, 1 to 6-seeded, cinereous-pubescent especially on the body, the wings much wider than body, often undulate-divided, the stipe exceeding calyx by 2 to 6 mm.

Type Locality: "In America calidiore." Linnaeus's references all relate primarily to Jamaica.

Specimens Examined:

Jamaica: Morant Bay, 1850, *March* (N. Y. Bot. Gard.). Berwich Hill, altitude 760 meters, 1899, *Harris* 7708. Hope Grounds, altitude 640 meters, 1903, *Harris* 8518 (N. Y. Bot. Gard.). Great Goat Island, 1906, *Harris* 9221. Vicinity of Kingston, 1910, *Brown* 364 (N. Y. Bot. Gard.).

The use of this species by the natives of Jamaica as a fish poison was known to many of the older writers. The species was apparently

[6] This combination was also published in November, 1891, by Kuntze (Rev. Gen. 1: 191).

first listed by Hermann,[7] in 1689, as "Coral arbor polyphylla non spinosa." Sloan,[8] in 1696, gave a long list of trees, mentioned by still older writers and travellers as fish poisons, which he doubtfully referred to this species. Ray,[9] in 1704, gave a good description of the plant and mentioned its use. A figure of the leafless flowering branch and of a portion of the fruit, with an account of this species and of other fish poisons, was also given in Sloane's Natural History of Jamaica.[10]

Ichthyomethia piscipula is readily distinguished by the pubescence of its leaves, and is probably confined as a native to Jamaica, where it is known as "dogwood." In the National Herbarium is a sheet from Key West, collected in 1896 by A. H. Curtiss (no. 5656), and another collected in Florida in 1877 by Garber. It is probable that both these specimens were taken from cultivated trees.

8. **Ichthyomethia cubensis** (Urban) Blake.

Piscidia cubensis Urban, Symb. Antill. 7: 229. 1912.

Shrub, 1 to 1.3 meters high; young branches greenish, densely rufescent-strigillose, the older branches gray, lenticellate, glabrate; leaves 5 to 9-foliolate, 2.5 to 4.5 cm. long; petiole (3 to 7 mm. long), rachis, and petiolules (1 mm. long) densely rufescent-strigillose; leaflets 1 to 2 cm. long, 6 to 11 mm. wide, oval to oblong, emarginate, apiculate, at base rounded to subcordate, coriaceous, prominulous-reticulate beneath, above light green, lucid, sparsely strigillose toward margin or glabrous, beneath obscurely strigillose chiefly along the veins; panicles rufescent-strigillose, 2 to 2.5 cm. long; pedicels 2 to 4 cm. long; calyx rufescent-strigillose, 4 mm. long, the lobes of lower lip deltoid, broadly rounded; corolla "pink or white" or "yellowish white;" vexillum 12.5 mm. long, subsericeous-strigose when young; lateral petals 13 mm. long (the claws 7 mm.), the limbs sparsely pubescent at base, sparsely ciliate at apex; keel 12.5 mm. long, (the claws 6.5 mm.), the limbs of the petals sparsely pubescent below toward base; vexillar stamen free for one-third its length; fruit linear, straightish, rufescent-strigillose, sometimes constricted between the seeds, 1 to 6-seeded, 2 to 4.8 cm. long, 5 to 7 mm. wide; wings 4, only 1 mm. wide; stipe equaling calyx; seeds olive-fuscous, 4.8 mm. long.

TYPE LOCALITY: Riverside to Minas, Camaguey, Cuba.

SPECIMENS EXAMINED:

CUBA: Dry savanna, Riverside to Minas, Camaguey, April 1, 1909, *Shafer* 1171 (type collection; N. Y. Bot. Gard.). Rocky soil, Palm Barren, Santa Clara, March, 1911, *Britton & Cowell* 10179 (N. Y. Bot. Gard.). Rocky sides of arroyo, Palm Barren, April, 1912, *Britton & Cowell* 13293 (N. Y. Bot. Gard.).

[7] Par. Bat. Prodr. 328. 1689.

[8] Cat. Pl. Jam. 143. 1696.

[9] Hist. Pl. 3 (lib. xxxi.): 108. 1704.

[10] Voy. Jam. 2: 39. *pl. 176. f. 4–5.* 1725.

This very distinct species was described by Urban from Shafer's nos. 1171 and 1549, of which the former is here selected as type. Urban gives the maximum size of the leaflets as 2.5 cm. long, and 1.7 cm. wide, and the fruit as having wings up to 2 mm. broad.

Although the fruit of this species is very different in appearance from that of the other members of the genus, owing to the great reduction of the wings, the difference is only a comparative one. In its floral structure *I. cubensis* agrees precisely with other members of the genus, and the morphology of the fruit is the same.

ELECTRICITY.—*Methods of measuring conductivity of insulating materials at high temperatures.* F. B. SILSBEE and R. K. HONAMAN, Bureau of Standards.

The purpose of this paper is to describe some measurements carried out at the Bureau of Standards during the past two years, on the resistance of various insulating materials at high temperatures. This work was undertaken with a view to studying the relative merits of various insulators for use in spark plugs, and in particular to assist the Ceramic Laboratory of the Bureau in developing improved porcelain bodies for this purpose. The method finally adopted, as a result of this work, for the comparative testing of materials is described elsewhere.[1] The present paper will be confined to a description of the various phenomena observed in the experiments which led to the method finally adopted.

The electrical and thermal conditions under which a spark plug is required to operate differ considerably with the type of gasoline engine used. Measurements with imbedded thermocouples have shown that the temperature of the body of the insulator within the metal shell seldom exceeds 250° C. in water-cooled engines. The tip of the inner end, however, may reach temperatures as high as 900 to 1000° C. It therefore appeared desirable to study the resistivity of the specimens in the range of temperature between 200 and 900° C.

The electrical stresses applied to a spark plug insulator by the average magneto or battery coil ignition system used for firing gasoline engines, are quite peculiar and difficult to duplicate in

[1] Report of the National Advisory Committee for Aeronautics, 1918.

any method of measurement. The cycle of operation, following the opening of the primary breaker contacts, consists of a rapid rise of the potential applied to the spark plug from zero to a value sufficient to break down the spark gap in the engine cylinder. The breakdown voltage is of the order of 6000 volts and is reached in a few hundred thousandths of a second. After this, a comparatively low voltage (800 volts) maintains the electric arc between the spark points and lasts for a few thousandths of a second. Since the interval between sparks is of the order of 0.05 to 0.1 second, it will be seen that the average voltage applied over a complete cycle is quite low and has been found to be approximately 150 volts. These peculiar electrical conditions should be kept in mind when considering the various methods of measurement described below.

The materials studied in this investigation included porcelains, glass, steatite, mica, and fused silica, as these constitute the only class of substances sufficiently heat resisting for use in spark plugs. While the detailed studies of polarization, etc. described in this report were made on only a few of the porcelain samples, the same effects seemed to be present to greater or less degree in all cases and the process of conduction is probably similar in all of them. The work of earlier investigators[2] has shown the complex nature of the phenomena, but as yet no complete and satisfactory theory has been worked out to account for them.

APPARATUS AND SPECIMENS

Most of the work reported in this paper was done on cup-shaped specimens with flat bottoms 3 mm. thick. The principal advantages of this type of specimen are:

(1) The conduction takes place through the bottom of the cup, which is of definite and easily measured dimensions.

(2) The large area and small thickness of the bottom ensure a relatively large current even with material of high conductivity.

[2] GRAY, T. Phil. Mag. V, 10: 226. 1880. HAWORTH, H. F. Proc. Roy. Soc. London 81 A: 221. 1908. SOMERVILLE, A. A. Phys. Rev. 31: 261. 1910. CAMPBELL. Nat. Phys. Lab. 11: 207. 1914. KINNISON, C. S. Proc. Amer. Ceramic Soc. 17: 422. 1915. POOLE, H. H. Phil. Mag. 34: 195. 1917. BRACE, P. H. Trans. Amer. Electrochem. Soc. May 5, 1918.

(3) The path over the rim of the cup for any surface leakage is relatively long.

(4) A satisfactory contact can be made between the specimen and the electrodes by immersing the bottom of the cup in a conducting fluid (in these experiments melted solder) and by inserting some of this fluid inside the cup to form the upper electrode.

These specimens were used in the furnace shown in figure 1.

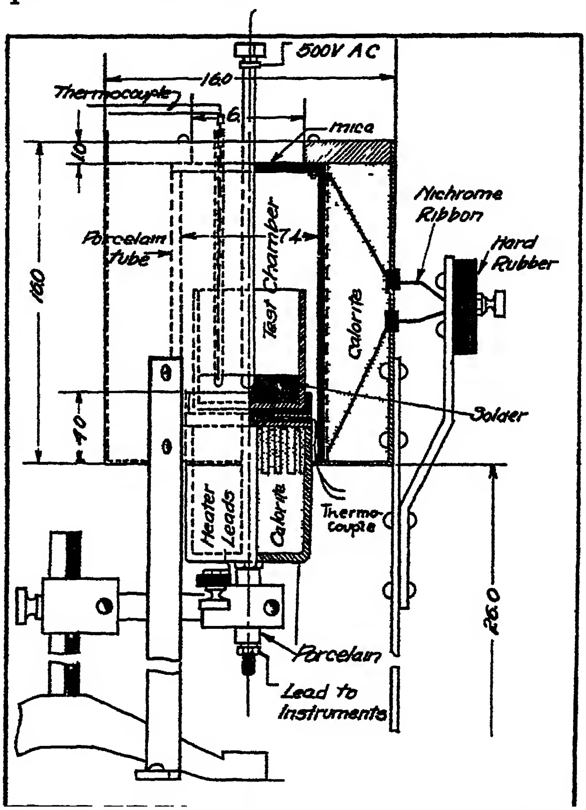

Fig. 1. Electric furnace as used in conductivity measurements.

The heating coil inserted in the plug below the specimen was found necessary to compensate for the flow of heat through the bottom of the furnace. By proper adjustment of the relative amounts of current through the main winding and through this additional coil, the temperatures inside and outside the cup could be equalized. These temperatures were measured by two copper con-

stantan thermocouples, one of which was inserted in a closed porcelain tube which dipped below the surface of the solder in the interior of the cup, while the other was imbedded in the steel cup containing the solder below the specimen. Readings of the resistance were taken only when these two thermocouples showed substantially equal temperatures.

In cases where cup specimens were not available, measurements were made on assembled spark plugs and also on spark plug insulators, and on short pieces of tubing. In these cases the conduction took place between a central electrode and either the shell of the spark plug or a band of platinum deposited around the center of the outside of the insulator or tube. The measurements with this type of specimen were definite in indicating the resistance of the specimen, but owing to the uncertainty as to the area of contact and the location of the lines of current flow, it is difficult from such data to compute with accuracy the true resistivity of the material.

For reducing the results of either type of specimen from the observed resistance to a basis of the resistivity of the material, the factors connecting these two quantities were computed from the dimensions of the specimens. For the cup specimen, the resistivity is obtained by multiplying the observed resistance by K, where

$$K = \frac{\pi d^2}{4t} \qquad (1)$$

and d is the diameter of the bottom of the cup and t the thickness of the cup in centimeters. For the tubular specimen

$$K = \frac{2\pi l}{2.30 \log_{10} \frac{R_2}{R_1}} \quad \text{(approx.)} \qquad (2)$$

where l equals the length of the external conducting band measured parallel to the length of the specimen, and R_2 and R_1 are respectively the external and internal radii of the insulator.

In most of the work the resistances were measured by reading a voltmeter connected across the specimen and an ammeter in series with it, and taking the quotient of these values as the re-

sistance. As will be seen from the following, a wide variety of sources was used to provide the applied voltage and the indicating instruments were correspondingly varied in character.

VARIATION OF RESISTANCE WITH TEMPERATURE.

The first experiments were carried out with an applied direct

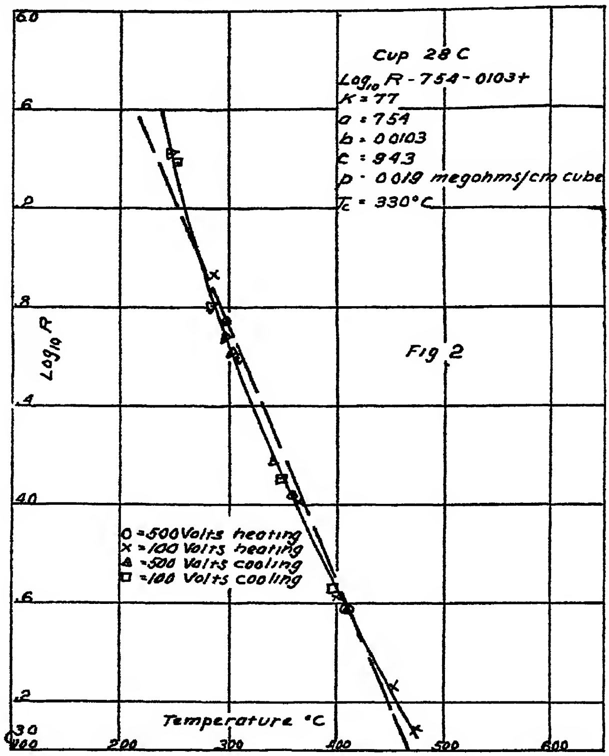

Fig. 2. Typical results on porcelain cup showing variation of resistance with temperature.

current voltage of about 2000 volts which was obtained by rectifying with a kenotron a 3000 cycle voltage supplied from a step-up transformer. This rather complicated system was chosen in an attempt to duplicate to some extent the voltages existing

in ignition systems, and although this source of voltage was later abandoned, the data obtained with it brought out the salient facts in regard to this type of conduction. The most striking of these facts, as verified by other measurements made later, is the very rapid decrease in resistance of the specimen with increase in temperature. This variation amounts to approximately 2 per cent per degree Centigrade at all temperatures. If the results are expressed by plotting resistance against temperature, or conductance against temperature the resulting curves are so steep as to render it impracticable to express the data over an extended temperature range by a single curve. It is found, however, that by plotting the common logarithm of the resistance against temperature, as in figure 2, a convenient line of slight curvature is obtained, and if this curvature is neglected, the results can be represented approximately by the equation

$$\log_{10} R = a - b\,t \tag{3}$$

This method of expressing the results is very convenient in reducing the data to a basis of resistivity, since combining the relation

$$\rho = K \times R \tag{4}$$

with equation (3) one obtains

$$\log_{10} \rho = a + \log_{10} K - b\,t = c - b\,t \tag{5}$$

In this equation b and c are constants of the material and are independent of the shape and size of the specimen used. Unfortunately, however, the values obtained for one of these constants depends very markedly upon the other, so that a slight error in one will cause a compensating change in the other. They are, therefore, not well suited for comparing the relative merits of the different materials and for this latter purpose it has been found convenient to compute an "effective temperature" (T_e), which is defined as the temperature at which the material has the arbitrarily selected resistivity of one megohm per centimeter cube, and which may be computed from the equation

$$T_e = \frac{c - 6}{b} \tag{6}$$

This value of T_e ranges from 350° C. in the poorer grades of porcelain up to 800° C. for fused silica, and is a convenient index of the value of the material as an insulator at high temperatures. There is a complete absence of any critical temperature at which the material undergoes an abrupt change in its resistance. This shows the error of the commonly accepted idea that porcelain breaks down and becomes conducting at a definite temperature. This belief probably originated from experiments in which the temperature of a porcelain sample was gradually raised while being continuously subjected to an applied voltage. The effect of the current flowing through the sample in such cases would be entirely negligible up to a certain temperature at which the power, $\frac{E^2}{R}$, supplied by the measuring current, became comparable with the rate at which heat could be dissipated to the surroundings. Owing to the very rapid rate of change of resistance with temperature, a very slight further increase in temperature would materially decrease the resistance and consequently increase the $\frac{E^2}{R}$ loss. Unless the specimen was in a position to give off heat freely to its surroundings, the temperature would rise rapidly causing a further decrease in resistance, thus leading to an unstable state which would rapidly cause the fusion of the material and the passage of an arc. The rapidity of change of resistance with temperature makes this point of instability quite definite, provided all the conditions of the experiment are maintained constant, but this apparent critical temperature will depend very greatly upon the contact between the specimen and the furnace, upon the applied voltage and other conditions, so that this is in no sense a specific property of the material.

The magnitude of this heating effect is exemplified by the behavior of a porcelain sample tested when hot, for example at 500° C. At this temperature, the resistance of a centimeter cube of ordinary porcelain is about 100,000 ohms, and if a voltage of only 500 volts per millimeter (*i. e.*, only about $^1/_{20}$ of that required to puncture it while cold) be applied, the current flowing will be 50 milliamperes and the power dissipated in the sample will be

250 watts This will suffice to raise the temperature of the sample at a rate of about 100° C per second and will cause its rapid destruction.

This heating of the specimen by the measuring current was observed on numerous occasions when making tests at 2000 and 1000 volts, and in each case the samples on removal from the furnace were found to contain one or more spots where the porcelain had been fused into a glass by the intense local heating. In the later work at lower voltage, this effect was not present, and readings were taken only when the current was substantially constant

POLARIZATION

The early measurements with high voltage direct current showed a number of puzzling discrepancies, such as a variation of the apparent resistance with the voltage used in making the measurement and with the time of application of this voltage Such discrepancies indicated the presence of an additional phenomenon to be reckoned with, which in the absence of definite knowledge as to its origin was called "polarization" and will be so referred to throughout this report.

The fundamental manifestation of this so-called polarization is that if a constant D. C. voltage be applied to a specimen, the resulting current will decrease at first rapidly, and then more gradually. The reduction in current is often equivalent to an increase in resistance by a factor of 10 or 20. If the specimen is allowed to remain at a high temperature but without applied voltage for some time, the effect gradually disappears, but a considerable time is required to accomplish this The disappearance is more rapid at high temperatures than at low. Figure 3 gives a record of the variation of the apparent resistance of a glass beaker, as measured with 1000 volts D. C. after various applications and removals of the measuring potential. The course of the experiment is indicated by the arrows and the duration of each period of application or of rest is indicated on the curve. The lowest and highest curves give the resistance as observed with very short application of the testing voltage just prior to the

polarizing test, and on the following day, respectively. The apparent permanent increase of resistance observed with this specimen serves to explain some mysterious results obtained at an earlier date, in which one specimen had shown an increase of resistance to more than twenty times its initial value after

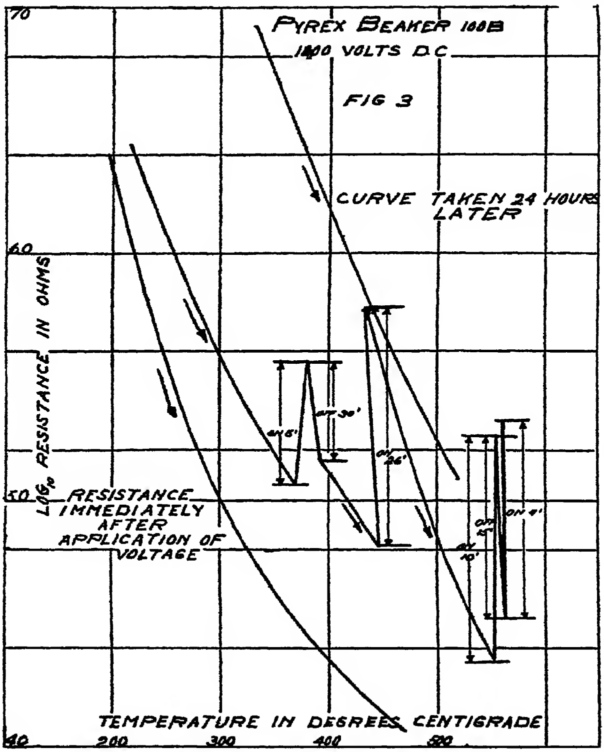

Fig. 3. Variation in resistance of glass cup resulting from polarization.

several successive tests. The fact that an appreciable time is required to obtain a reading, even with quick acting direct current indicating instruments, and that during this time the specimen is being polarized, is probably a complete explanation of the variation of apparent resistance with applied voltage. If the

applied D. C. voltage is suddenly reversed after a specimen has become polarized to a considerable extent, the initial current in the new direction is found to be approximately equal in magnitude to the original current and much greater than the value immediately preceding the reversal. This implies a counter E. M. F. and an attempt was made to observe such an effect by connecting an electrostatic voltmeter across the specimen. No residual deflection of this meter was observed when the supply current was removed, even after long continued polarization of the specimen. This result is to some extent in contradiction to facts mentioned by other observers.[3]

A magneto having alternate distributor points of the same polarity connected together was also used as a source of voltage and the polarizing effects found to be in every way similar to those obtained with a steady D. C. source of the same average voltage (150 volts).

When alternating current is applied to a fresh specimen, there is no polarizing effect and the current remains constant indefinitely, except when the current is so large as to produce heating of the specimen. When alternating current is applied to a specimen which has been previously polarized by direct current, the polarization disappears at a more rapid rate than if the alternating current had not been applied.

An attempt to throw light on these complex phenomena was made by applying alternating and direct current simultaneously to a specimen. This was accomplished by connecting a transformer in series with a generator. By opening the primary circuit of the transformer, or the field of the generator, either source of E. M. F. could be eliminated without opening the circuit or interfering with the current flow from the other source. The A. C. voltage was measured across the transformer terminals with a moving iron voltmeter, and the D. C. voltage by a d'Arsonval type D. C. voltmeter across the generator. The alternating current through the specimen was passed through the moving coil of an electro-dynamometer, the fixed coil of which was excited by an alternating current of constant magnitude and in

[3] MAXWELL, J. C. Electricity and Magnetism. Ed. 3. 1: 393.

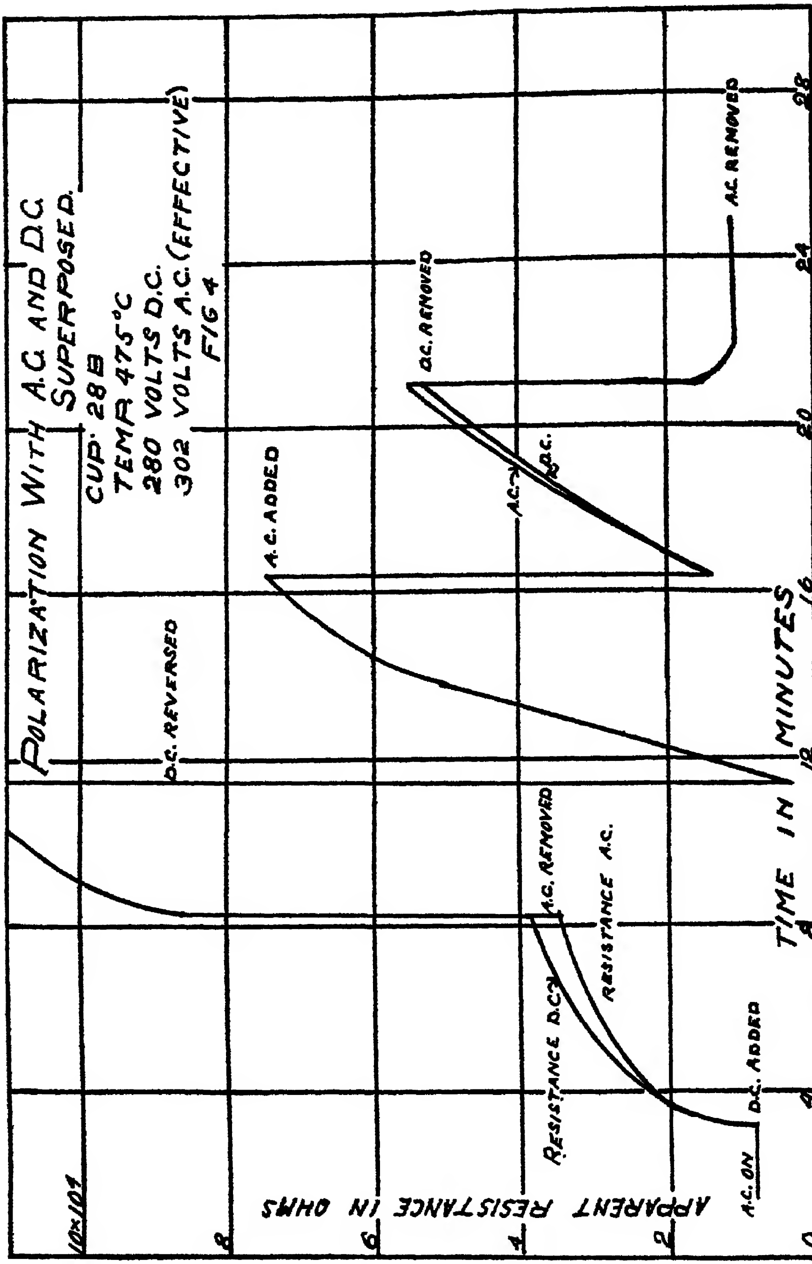

Fig. 4. Polarization with alternating current and direct current superposed.

the same phase as the alternating voltage applied to the specimen. The direct current through the specimen was measured by a D. C. milliammeter connected in series with the specimen and the dynamometer. With this arrangement, each pair of instruments measured only its particular component of the resultant current and voltage and was not affected by the presence of the other component. Figure 4 shows the variation with time during the course of the experiments of the resistances as computed from the two components of the current. In this experiment the maximum value of the A. C. voltage was greater than the D. C. voltage, so that the resultant voltage applied to the specimen reversed in sign during each alternation. Other experiments, in which the maximum alternating voltage was less than the D. C. voltage, and the resultant voltage was consequently unidirectional, showed substantially the same effects. Throughout the experiments, the temperature was held as nearly constant as possible, but a gradual drift of resistance will be noticed, which can be accounted for by a slight change of temperature. It appears from these results that the resistance of the specimen is substantially the same for both the alternating and direct currents for all states of polarization. Or, in other words, the polarization produced by the direct current offers resistance to the passage of the alternating current and the depolarization produced by the alternating current reduces the resistance offered to the passage of the direct current.

When alternating current alone was applied to a fresh specimen, the power factor of the circuit was found to be substantially unity. If, however, the specimen had recently been polarized by the application of direct current, the power factor was somewhat reduced; values as low as .9 having been observed.

The data described above are quite insufficient for the development of any complete theory of this "polarization," but it would appear that the assumption of a counter E. M. F. is ruled out by both the experiments of combined alternating and direct current and by the difficulty of imagining a mechanism capable of producing a counter E. M. F. of the order of several thousand volts, which would be required to produce the observed decrease

of current. A possible explanation may be developed on a basis of the migration away from one electrode, of the ions carrying the current, thus leaving a scarcity of carriers for the further passage of current in the original direction, but providing a plentiful supply for currents in the reversed direction. Another suggested explanation is the formation of resisting films which may cover a considerable part of the area of the electrodes but which are readily removed by electrolysis on reversal of the current. Tests made using platinized surfaces as electrodes instead of the melted solder showed no difference of behavior. It may be noted in this connection that when the samples were removed after cooling, the solidified solder adhered firmly to both surfaces of the cups which had been tested with direct current, but could be very readily peeled off from specimens which had been tested on alternating current.

DISCUSSION OF METHODS FOR MEASURING RESISTANCES

As a result of the data obtained in the preliminary experiments just described, it was decided to adopt as the most satisfactory method for the rapid comparison of different types of insulating materials, the volt-ammeter method using alternating current. Under these conditions the observed resistance is substantially independent of the frequency, voltage and time of application, and the convenient values of 60 cycles and 500 volts were adopted for the later work. Figure 2 shows the typical results obtained by this method and indicates the agreement attainable on successive runs even at different voltages. It should be remembered, however, that the results thus obtained are for the material in the unpolarized state and, when in actual use in ignition systems, the material may show a much higher resistance to the unidirectional impulse from the magneto.

Of other possible methods for such work, a bridge method using D. C. would be objectionable because of the variable amount of polarization which would occur. Attempts were made to use alternating current as a source but the measurements are complicated by the effect of stray capacities shunting the high resistances which are necessary, and the time required to

obtain a balance on the bridge is a serious draw-back because of the rapid change in the resistance to be measured with even slight drifts of temperature.

The megger, while extremely rapid and convenient, is open to the disadvantages of polarization and to the fact that the voltage supplied varies very considerably with the resistance of the specimen under test.

The use of a magneto in place of alternating current as a source has the great advantage that it approximately duplicates the conditions of operation in the engine. The magneto, however, is very variable in its output, both from instant to instant and as a result of permanent changes in the magnets, contact points, etc. Moreover, there is an abrupt change in the operation of the machine when the resistance of the specimen becomes so low as to cause the spark in the safety gap to cease, and also the total variation of the current delivered with various resistances in the circuit is comparatively slight, with this type of machine.

A method involving the measurement of the rate of loss of charge from a condenser connected in parallel with the specimen has been used by Cunningham. This method imitates the conditions of operation much more closely than does the A. C. method but not as perfectly as the use of a magneto as a source. The principal objections are the very delicate string electrometer which is required and the necessity of recording the result photographically.

TYPICAL RESULTS AND CONCLUSION

The following table gives the results obtained by the use of the alternating current method on a number of types of samples, the significance of the various constants being the same as those defined on page 257.

These figures show a wide variation in the resistance of the different materials but a rather surprising similarity in the constant *b* which is a measure of the temperature coefficient of their resistance. It should be mentioned in this connection that while successive measurements with alternating current on a single specimen give results repeating to a few percent, yet measure-

TABLE 1

RESISTIVITY OF INSULATING MATERIALS

Material	c	b	T_e	ρ at 500° C.
Fused silica	11.8	.0065	890° C.	340×10^6
Best porcelain tested	11.2	.0066	790	80×10^6
Typical mica plug	12.1	.0085	720	70×10^6
Average three aviation porcelains	11.5	.0085	650	40×10^6
Average automobile porcelain	10.2	.0085	490	0.8×10^6

ments on different specimens of material which are supposed to be identical show wide variations in resistivity amounting in some cases to a factor of 10. This fact tends to indicate that the conduction is due to a considerable extent to the presence of small amounts of impurities which may vary greatly in amount without appreciably affecting the composition of the material as a whole.

It appears from the above data that the A. C. method developed is very practical and convenient for comparative measurements on samples of this character, but that there is a very wide field of investigation concerning the phenomenon of polarization and much interesting work may be done in developing theories as to the precise mechanism by which conduction is carried on in this class of materials.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

The Board of Managers met on April 14. Routine business was transacted and new members elected. Mr. H. V. HARLAN was appointed an associate editor to succeed Mr. J. B. NORTON, who had resigned on account of absence from Washington.

The following persons have become members of the ACADEMY since the last issue of the JOURNAL:

Professor CHARLES O. APPLEMAN, Maryland Agricultural Experiment Station, College Park, Maryland.

Miss ELEANORA F. BLISS, U. S. Geological Survey, Washington, D. C.

Mr. HARRY V. HARLAN, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

Dr. S. L. JODIDI, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

Mr. IRWIN G. PRIEST, Bureau of Standards, Washington, D. C.

ROBERT B. SOSMAN, *Corresponding Secretary.*

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 812th meeting was held at the Cosmos Club, January 18, 1919. President HUMPHREYS in the chair, 48 persons present. The minutes of the 809th and 811th meetings were read in abstract and approved.

The paper of the evening was presented by Major L. T. SUTHERLAND on *Some of the accomplishments of the research division of the chemical warfare service.*

There was no discussion of the paper as such. However, the speaker expressed his willingness to answer questions and his replies to the questions asked him brought out many interesting points.

Upon motion duly seconded a unanimous vote of thanks was tendered the speaker. Adjournment took place at 10:09 p.m., following which there was a social hour with light refreshments.

The 814th meeting was held at the Cosmos Club, February 15, 1919. President HUMPHREYS in the chair, 45 persons present. The minutes of the 813th meeting were read in abstract and approved.

The first paper was presented by Mr. L. A. BAUER on *The field of a uniformly magnetized elliptic homoeoid and applications.*

There have been repeated occasions in the course of the author's investigations when he had need for the simplest possible expressions defining the magnetic field of certain magnetized bodies, such as ellipsoids of revolution, homoeoids, focaloids and cylinders. A variety

of investigations will be found in treatises and papers by eminent authors, but the derived expressions either stop at the gravitation potential and intensity components, or but special cases of magnetization are treated. Furthermore the published expressions for general cases are often needlessly complex or they contain errors of one kind or another which in some instances have been repeated by later authors. Hence, the attempt was made to derive the desired expressions in the simplest manner possible for practical application. Certain war problems gave added zest to this attempt.

According to Poisson, who first solved the problem of induced magnetism in an ellipsoid placed in a uniform magnetic field, if V' be the gravitation potential at the point (x, y, z) of a body of uniform density ρ, then $-\frac{\partial V'}{\partial x}$ is the magnetic potential of the same body uniformly magnetized in the direction x with the intensity $A = \rho$. Similarly with regard to any other direction of uniform magnetization. If the uniform magnetization results from magnetic induction, the magnetizing field at all points in the interior of the body will be uniform. So that if the external magnetizing field is uniform, the magnetic field resulting from the magnetization will also be uniform for all points in the interior of the body.

The ellipsoid is the only body for which $\frac{\partial V}{\partial x}$ is a linear function of the coordinates x, y, z in the interior, and V, accordingly, a quadratic function of the coordinates. Poisson's method can, therefore, be applied to the case of the ellipsoid.

Hence if A, B and C be the intensities of magnetization parallel to the three axes of the ellipsoid, and X', Y' and Z' the components of gravitational intensity due to a homogeneous ellipsoid of uniform density $\rho = 1$, the magnetic potential due to the ellipsoid at any external point as resulting from the induced magnetization will be

$$V = AX' - BY' - CZ' \qquad (1)$$

As defined by Thomson and Tait[1] "an elliptic homoeoid is an infinitely thin shell bounded by two concentric similar ellipsoidal surfaces." The total intensity produced by such a shell at points within the hollow interior is zero, and at external points anywhere infinitely near the homoeoid it is perpendicular to the surface, directed inward and equal to $4\pi\rho t$, where ρ is the constant density of the homogeneous mass and t is the thickness of the shell at the point for which the intensity is sought.[2] Since, furthermore, any two confocal homoeoids of equal masses produce the same intensity at all points external to both, we have in general that the *total intensity produced by a homogeneous elliptic homoeoid at an external point* (x, y, z) *is equal to* $4\pi\rho t$, ρ *being the constant density and* t *the thickness of the elliptic homoeoid at the point* (x, y, z),

[1] Thomson and Tait's Natural Philosophy. Pt. 2: 43, footnote 2.

[2] Idem. Pt. 2: paragraphs 519–525.

confocal to the given homoeoid and passing through x, y, z; the intensity is along the normal and directed inward, or towards the given shell.

On the basis of equation (1) and MacLaurin's theorem the author has deduced:

1. Expressions for the field of an inductively magnetized rotation ellipsoid in a more convenient form for the general case than previous ones.

2. Expressions for the field of an inductively magnetized prolate elliptic homoeoid have been established, possibly for the first time.

It was also shown that expressions in finite form may be established for the field of an inductively magnetized elliptic homoeoid in general—that it is not necessary to assume a rotation elliptic homoeoid. This matter is of special interest in view of the fact that expressions for the field of an inductively magnetized solid ellipsoid, in general, have not yet been established in finite form.

In conclusion various applications of the derived formulae were given.

The paper was illustrated by lantern slides and was discussed by Messrs. ABBOT, LITTLEHALES, SOSMAN and HUMPHREYS.

The second paper, also illustrated by lantern slides, was presented by Mr. S. J. MAUCHLY on *Some results of atmospheric-electric observations made during the solar eclipse of June 8, 1918.*

The observations forming the subject of this paper were made in the belt of totality near Lakin, Kansas, in accordance with the general plan of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington for magnetic and electrical observations during the total solar eclipse of June 8, 1918. The observing station was located on a level treeless plain and the general weather conditions on the afternoon of the eclipse were favorable for atmospheric-electric observations. The period of totality at Lakin was of about 84 seconds duration.

The potential-gradient was determined from eye readings of an electroscope giving the p. d. between the earth and an ionium collector supported at a distance of 95 cm. above the ground, from the middle of a long, insulated, horizontal wire. Observations were made every two minutes over a period of 6 hours approximately symmetrical about the time of totality. The main results may be summarized as follows:

(1) Beginning 8 minutes before and continuing throughout totality there was a rapid but nearly uniform decrease of the potential-gradient amounting to about 25 per cent of the values immediately preceding. The general minimum thus established persisted for about 20 minutes after totality and was marked by a sharp secondary minimum 6 minutes after mid-totality.

(2) Throughout the general minimum referred to there was *almost total absence* of the irregular, short-period, fluctuations which characterized the potential-gradient on the afternoon of the eclipse. Beginning 20 minutes after totality and continuing for about 20 minutes there was a marked but gradual increase to approximately normal

values of both the gradient and the amplitude of its short-period fluctuations.

For the observations of the specific conductivity of the air the aspiration apparatus devised by Gerdien was employed. By the use of a separate apparatus for each, it was possible to make approximately simultaneous observations of the positive and negative conductivities. The time for a single determination was 2 minutes, and, except for the time required for making frequent calibration and leak tests, the observations were made continuously throughout a period of 6 hours symmetrical about totality. The results showed, for both signs, a very marked increase in conductivity just before totality. These abnormal values continued for about 20 minutes after totality when both conductivities began to decrease. The time of return to normal afternoon values, for both signs and also for the total conductivity, corresponded very closely to the time when the potential-gradient regained its normal values.

A short résumé of the results of atmospheric-electric observations during previous eclipses by other observers was also given and comparisons made with the foregoing.

Adjournment took place at 10.20 p.m. and was followed by a social hour and refreshments.

The 816th meeting, a joint meeting with the Washington Academy of Sciences, was held at the Cosmos Club, March 15, 1919, President Humphreys presiding.

The address of the evening was given by Dr. H. D. Curtis on *Modern theories of spiral nebulae.*

This address was illustrated by lantern slides and has appeared in this Journal (9: 217. 1919).

S. J. Mauchly, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

Dr. Paul Bartsch, of the National Museum, has returned from an extended lecture tour to various army camps.

Mr. C. F. Bowen resigned from the Geological Survey in April to enter the employ of the Carter Oil Company. He will leave soon for a six months' trip in Venezuela and Colombia.

Mr. F. W. Dearborn of the Ordnance Department has joined the staff of the Bureau of Standards and will be engaged in research on the chemistry of cellulose.

Mr. Wilson B. Emery resigned from the Geological Survey in April to enter the employ of the Ohio Oil Company at Cheyenne, Wyoming.

The Chicago Speedway Hospital has been turned over to the Public Health Service, and two of the seven subdivisions of the building will be devoted to research and to the instruction of public health officers. This part of the work of the hospital will be under the direction of Dr. Joseph Goldberger, of the Hygienic Laboratory.

Dr. J. A. Harker, formerly of the National Physical Laboratory, in London, visited Washington in March on business connected with the organization of scientific and industrial research in England.

Mrs. Phoebe Apperson Hearst, a patron of the Academy, died at her home at Pleasanton, California, on April 13, 1919, in her seventy-seventh year. She was the widow of the late Senator George Hearst, of California, coming with him to Washington in 1886. She took an active part in educational affairs during her residence in the city. She was elected a patron of the Academy in 1901.

Mr. O. B. Hopkins, of the Geological Survey, is on leave of absence and is engaged in work for the Imperial Oil Company in Canada.

Mr. H. E. Howe, formerly manager of the commercial department of A. D. Little, Inc., of Cambridge, Massachusetts, will hereafter devote his efforts to the interests of the National Research Council and particularly to the work of its Division of Industrial Research. Mr. Howe was attached to the Nitrate Division of the Ordnance Department, U. S. A., during the latter part of the war.

Mr. M. B. Long, of the gas laboratory of the Bureau of Standards, has resigned in order to accept a position in the research laboratory of the Western Electric Company, in New York City.

Mr. J. B. Norton, of the Bureau of Plant Industry, who has been appointed Agricultural Explorer in the Office of Foreign Seed and Plant Introduction, has left Washington on an expedition to China.

Mr. B. E. Sive, formerly of the chemical reagent testing laboratory

of the Bureau of Standards, is now with the American Colortype Company of Chicago, Illinois.

The Treasury Department published in April a "Manual for the Oil and Gas Industry under the Revenue Act of 1918," designed to assist the oil and gas producer to calculate the depletion of his reserves. Attention is called to the publication here as it is not issued by one of the scientific or technologic bureaus and might not reach the scientific public through the usual channels.

The Division of Biology and Agriculture of the National Research Council met in Washington, April 14. Fourteen members were nominated by 10 national societies of biology and agriculture, 3 each from the Botanical Society of America and the Society of American Zoologists, and one each from the other societies. These members nominated 8 members at large. The Washington members are: G. N. Collins, American Genetic Association; A. S. Hitchcock, Botanical Society of America; George R. Lyman, American Phytopathological Society; Charles V. Piper, American Society of Agronomy; A. G. Mayer, Carnegie Institution; C. F. Marbut, Bureau of Soils; H. F. Moore, Bureau of Fisheries, members-at-large.

JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 9 MAY 19, 1919 No. 10

PALEONTOLOGY.—*Significance of divergence of the first digit in the primitive mammalian foot.* JAMES WILLIAMS GIDLEY, U. S. National Museum.

In connection with some recent research work on Basal Eocene mammals I have had occasion to make a critical study of the primitive mammalian foot, especially as regards the meaning of divergence of the first digit. On the interpretation of this character depends in no small degree our concept of the early life history of the Mammalia.

Based on certain modifications observed especially in the hind feet of marsupials, including divergence and opposability of the hallux associated with a tendency to enlargement of the fourth digit and reduction and syndactylism of the second and third digits, Huxley in 1880[1] expressed the view that the existing marsupials have been derived from an arboreal ancestry. Later Dollo,[2] in full accord with this view, discussed the evidence for it at considerable length. Soon followed a review by Bensley[3] in which he expressed general agreement with the interpretation of Huxley and Dollo. In 1904 Matthew published an article on "The Arboreal Ancestry of the Mammalia,"[4] in which he accepted the views of Huxley, Dollo, and Bensley regarding the arboreal ancestry of the marsupials, and expressed his belief that the

[1] Proc. Zool. Soc. Lond., p. 655.

[2] *Les ancêtreses Marsupiaux etaient-ils arboricoles?* Miscellanées biologiques, 1899.

[3] Amer. Nat. 35: 117–122. 1901.

[4] Amer. Nat. 38: 813–815. 1904.

placentals are likewise of arboreal origin. This latter belief was apparently based, principally at least, on the fact that the first digit, in both the fore and hind feet of the early Eocene mammals of generalized type is so frequently found in a divergent position, and on the condition found in the earliest known Primates But unlike Huxley and Dollo, who considered arboreal adaptation in the marsupials a specialization and not a primitive condition, Matthew advanced the hypothesis that opposability of the first digit in the early mammals was a primitive condition. While I do in the main indorse Matthew's characterization of a hypothetical "common ancestral group," I am unable to agree with him regarding arboreal ancestry as applied to placentals in general, and therefore differ from him in the interpretation of the conditions found in the primitive mammalian foot. In order more clearly to set forth my own view I here quote the principal arguments advanced by Matthew in support of his interpretation:

(1) In the first place, as far as we can trace back the history of each of the arboreal groups, we find their first ancestors with the first digit as fully opposable as in the modern representatives (*e. g.*, the Middle Eocene primate *Northarctus*).

(2) Second, in those groups which have not an opposable thumb, we find as we trace back their ancestry that the trapezium, whose form and facets give the surest indication on this point, approaches more and more nearly to the type preserved in the Primates, etc.

(3) In the four Basal Eocene mammals (Pantolambda, Euprotogonia, Claenodon, and Dissacus) in which this part of the skeleton is known, the form of the bone [trapezium] is surprisingly uniform, and when the manus is put together, the first digit is thrown partly outward from the rest of the hand, and permits of much freer motion than the remaining digits, with a considerable degree of opposition.

Following this, in the same article, Matthew states that the primitive opposability of the hallux is less clearly indicated but suggests this is due to the probability that the evolution of the hind foot for terrestrial locomotion "began earlier or proceeded more rapidly." He further suggested that "the hypothesis that all mammals passed through a stage when the pollex and hallux were opposable," would explain among other things, "(a) the presence of but two phalanges on digit 1, three on each of the others; (b) the epiphysis of digit 1 being proximal as in the

phalanges, instead of distal as in the remaining metapodials; (c) the anomalous musculature of digit I on all mammals, the object of which is clearly seen when the digit is opposable, but is quite unexplained otherwise." In further substantiation of the arboreal ancestry hypotheses, Matthew's first proposition above quoted has, I believe, little weight as evidence. First, because *Notharctus* can hardly be considered primitive, since the known species, even in the Bridger epoch, had advanced in foot, limb, and skull structure well toward the condition found in the present-day South American apes; second, admitting *Notharctus* to be primitive, the presence of true opposability in this genus can affect the proposition under discussion only so far as the Primates themselves are concerned, and cannot be taken as evidence of arboreal ancestry for other orders of mammals, especially as there is no indication of close relationship between any of them and the Primates.[5] At most the evidence in the case of *Notharctus* can not be interpreted to mean more than that the group which it represents (the Primates) had adapted themselves to an arboreal habitat at a comparatively early period. But opposability probably followed or accompanied and did not precede their adaptation to tree-living habits. If this be true it explains why there are so many cases in which opposability has not been developed even in strictly arboreal forms, and likewise why these cases seem to be confined to species of comparatively small size. For example, many species of rodents and insectivores are living to-day almost exclusively in the trees, yet, so far as I am aware, there is not one example of true opposability among the Insectivora, and but one among all the Rodentia, living or extinct. This single exception is furnished by the African genus, *Lophiomys*, in which the first digit of the hind foot is thus developed, and this animal is not arboreal. Among the Insectivora some of the Tupaiidae are mostly arboreal in habit, more so than in any other members of the order, yet even in this family there is not the slightest trace of opposability.

[5] It may be here remarked that, in my opinion, there is some evidence that this important order, and probably some other orders of mammals as well, have been derived independently from different though probably more or less closely related premammalian ancestral groups.

Among the Primates themselves there is a whole group of living species, the South American marmosets, that, in the fore feet at least, show no evidence of opposability, although they are strictly arboreal in habits. These smaller, lighter-bodied animals seem never to have acquired the function of grasping a limb, but depend rather on their sharp, widely spread claws for support in progressing among the tree tops.

Matthew's second and third propositions, above quoted, do not strictly concern opposability but refer rather to simple divergence of the first digit. And the crux of the whole proposition seems to lie, after all, in the interpretation of this condition.

"Primitive opposability" and "more or less opposable" are terms which the advocates of arboreal ancestry have frequently used, but have never clearly defined. These terms seem to express a condition somewhat different from the kind of opposability developed in the modern Primates, and as used by Matthew, as I interpret it, seem to imply that simple divergence of the first digit may be taken as proof of opposability or at least former opposability. It becomes necessary then, to distinguish clearly between "opposability" and "divergence" of the first digit, as for an intelligent discussion, one should understand clearly what is meant by "opposability." As applied to arboreal adaptation opposability can imply but one condition, *viz.*, a modification which gives the power to grasp or hold, by opposing the first digit to the others, and this is always accompanied by a special and distinctive arrangement and development of the digital muscles. Opposability, it is true, is usually accompanied by a complete divergence of the opposing digit,[6] but divergence, in all stages, is frequently observed where there is no other evidence of opposability. Moreover, examples of divergence without opposability are found most frequently in the older Eocene representatives of almost all the orders of mammals in which the feet are known, while true opposability has not

[6] An exception to this is seen in some of the phalanges in which the first metacarpal is closely appressed to the second, but the toe is opposable and divergent in its phalangeal portion.

been found in any forms of older age than the middle Eocene; and here it is known only in species of a single order. These facts, together with the absence of opposability in tree-living rodents and insectivores, as already pointed out, would in themselves suggest that this condition of opposability is relatively modern in development, or at least not primitive; and in further support of this view it may be noted that in those orders in which opposability has been developed and retained, it is always most advanced in those species which are in other respects notably specialized. Thus, in the Primates, opposability, especially in the hind feet, is found best developed in the heavier, long-limbed monkeys and apes. It has reached its greatest perfection in the hand of man, although doubtless the higher stages of perfection of this function were accomplished after man, formerly arboreal, had finally taken to a terrestrial habitat. Contrary to what one might expect, if opposability were a primitive condition, in the little marmosets of South America, which among living Primates are considered a rather primitive and generalized group, there is, as already stated, not the slightest approach to opposability of the pollex, which is long and functional and it is only moderately developed in the hallux. Yet these little animals are as strictly arboreal in habits as any group of the order. If opposability of the first digit is a primitive condition, then why is it so poorly developed in this particular group while so well developed and perfected in the more highly specialized members of the order? Granting that all Primates began their career in an arboreal habitat, it seems to me a more logical conclusion that the little light-bodied marmosets have never developed opposability, finding the primitive sharp claws sufficiently effective for clinging to the bark of trees, while the heavier-bodied forms, or those species which early formed the habit of swinging from limb to limb as a method of progression through the trees, very quickly took advantage of the *primitively divergent* first digit to develop opposability. This function once developed to a degree where the grasp became firm, the claws would no longer act as formerly, and the constant pressure thus transferred to the palmar side of the toe, or finger tips, would soon modify them into the "nail," so characteristic of the Primates.

If by the term "primitive opposability" is meant simple divergence of the first digit, it seems to me purely assumption, based on no convincing evidence, to interpret this condition as denoting an arboreal habitat. This interpretation, moreover, seems not warranted without the most positive proof, especially when such a foot as that of *Claenodon*, for example, or any other primitive mammalian foot of the basal Eocene types shows no evidence of true opposability and, moreover, could be derived, with such comparatively slight changes, directly from the primitive reptilian type of foot. In fact it is but a short step in mechanical adaptation from the reptilian state to the type of foot of which *Claenodon* is a somewhat advanced example. On examining a foot of *Sphenodon* or other reptile of generalized type, the distinctly reptilian characteristics seem to be these: Foot completely plantigrade; metapodials all more or less divergent, permitting free spreading of the digits; metapodials shorter than phalangeal portion of the digit; first digit shortest; fourth digit longest of the series; phalangeal formula digits I to V, 2, 3, 4, 5, and 3 or 4, respectively. Comparing now the type of foot under discussion. The following seem to be the principal modifications which mark its advance over the reptilian type: The foot has remained plantigrade with the metapodials shorter than the phalangeal portion of the digit and with digit IV, though relatively shortened, still longest of the series; digits II to V are drawn somewhat more closely together, but are still capable of considerable spreading; the first digit, retaining more or less its original reptilian position, is left more divergent than the others; and the phalanges of the median two digits are reduced to the mammalian number, three in each digit.

These simple modifications seem to be purely mechanical adaptations brought about in changing from the reptilian crawling manner of locomotion, to the mammalian walking gait, and each modification may be readily explained on this hypothesis. In the normal position a reptile or batrachian carries the feet well out from the body, with the toes directed more or less outward in such a manner that the short first digit is directed first inward then forward toward the end of the stride, the heel re-

maining on the ground, so that normally the weight of the body is not brought fully on the ends of any of the metapodials. In terrestrial mammals, even of the most primitive plantigrade type, the feet are brought more under the body in walking, the radius and tibia, respectively, are brought to the inside, the first digit pointing constantly inward and the others more or less directly forward. The result of this modification would be to bring the weight of the body more exactly on the ends of the median toes, especially at the finish of the stride at which time the heel is raised clear of the ground. This would have a tendency to stiffen the wrist and ankle joints, through a closer articulation of their bony elements, to bring the divergent metapodials more closely together, and to shorten the median pair of toes. This change in position of the feet and consequent change of the manner in which the toes are applied to the ground in walking may have been the primary cause of the reduction in phalanges of digits III and IV, and would quite satisfactorily account for the divergence of the first digit so frequently found in the primitive mammalian foot. It will be especially noted that the first digit is shortest, and in the mammalian position of the foot is so placed as to take no considerable part in the function of walking, hence it has been least modified and soonest lost in terrestrial forms which acquired a digitigrade gait.

It is plainly obvious that, from a central type of primitive mammalian foot similar to that just described, in which the first digit is unreduced, it is but a short step to true opposability. The divergent first digit could readily be converted into a grasping organ, and the modification to opposability doubtless was soon accomplished by those forms which early adopted an arboreal habitat. But among ground-living forms, in the other direction, it was an equally short step to the strictly terrestrial digitigrade type, in which the first digit was gradually atrophied, as it became functionless through being raised from the ground, and in many species has been lost altogether. In the process of development of the digitigrade type the functional metapodials are brought closely together and have become relatively lengthened while the phalangeal portion of these digits becomes shortened. It is through these stages of development that have

come directly the modern ungulate types of feet. Still another type developed from the primitive terrestrial mammalian foot, or possibly directly from the reptilian stage, is that type of which the short-toed amblypod and probosicidian feet are examples. In these forms the toes remain more or less spreading, and all, including the first when present, function in bearing the weight of the body. In this type of foot the heel may become raised from the ground as in the digitigrade type, but this modification is always accompanied by the development of a pad so that this portion of the foot still functions in carrying its share of the body-weight as in the plantigrade type. It may be further assumed that the various aquatic types of feet are directly derivable from some such foot as that of *Claenodon*.

It would thus seem that the primitive mammalian foot, of the central group, must have been primarily terrestrial, and from this generalized type of foot, with *divergent* but not *primarily* opposable first digit, have been developed all sorts of modifications of foot structure, each adaptable to the kind of environment chosen, and that divergence of the first digit is primarily an inheritance from the primitive reptilian condition, and can not be considered as in any way supporting the hypothesis of an arboreal ancestry of the Mammalia. It is likewise quite as apparent, it seems to me, that true opposability of the first digit wherever found should be considered a direct specialization of the primitive condition brought about by a mechanical adaptation to a peculiar (arboreal) life habit.

This viewpoint is certainly not weakened and seems to be strengthened by the difference in type of modification observed in the hind foot of marsupials as compared with that of the Primates. In the former, as observed by Huxley, opposability of the first digit is accompanied with enlargement of the fourth digit, and reduction and syndactylism of the second and third digits, while in the latter there is no approach to either of these modifications. This difference seems to be fundamental, and suggests that the marsupials took to tree-living habits at a somewhat earlier stage of development while the fourth digit was yet considerably longer than the others, and for that reason more directly opposed by the first digit.

INTERFEROMETRY.—*The use of the interferometer in the measurement of small dilatations or differential dilatations.* C. G. PETERS, Bureau of Standards. (Communicated by S. W. Stratton.)

The dilatometer originated by Fizeau and further developed by other investigators consists of two interferometer plates separated by three pins of slightly different length, made in the form of a tripod or ring. When this interferometer is illuminated and viewed in the proper manner, curved interference fringes appear. The change in the length of the pins is determined from the displacement of these fringes past a reference mark, which is usually ruled in the center of the lower surface of the upper mirror. The quantity that is actually determined, however, is the change in the distance between the two plates at the reference mark, which is equal to the change in length of the pins, if their behavior is identical, or nearly equal to their mean, but not their individual change in length when they behave differently. In fact, two of the pins may expand while one contracts, or the three pins may change in such a manner as to cause the fringes to rotate through 360° without causing any displacement of the fringes past the reference mark. The unequal variations in the length of the pins cause the direction and angle of the wedge between the plates to change, which in turn changes the direction and width of the fringes. This was slightly noticeable in our work with three pins of steel, quartz, brass, or copper, and quite pronounced with glass near 600° C. H. G. Dorsey[1] observed this fact in his work on the thermal expansion of zinc.

The exact change in length of each individual pin can be determined from the change in the order of interference (the number of light waves) between the plates at the points of contact of the pins. This was accomplished without changing the Fizeau apparatus in any way except to make the reference marks at these points of contact. The pins were made in the form of cones, about 4 mm. across the base and 10 mm. long. Three

[1] Phys. Rev. 26: 5. 1908.

conical holes, 0.5 mm. in diameter, 0.2 mm. deep, and about 15 mm. apart, were drilled in the lower surface of the cover plate. The pins were placed between the interferometer plates so that the points of the cones fitted into the holes in the cover plate. These holes kept the pins in their triangular positions, stopped any creep of the cover plate and served as reference marks in the determination of the change in length of the pins. The fringes were viewed with a Pulfrich[2] apparatus. With this instrument the part of the interference pattern which is obscured by the pins can be easily bridged with the crosswires.

Let the lengths of the three pins be designated as A, B, C, the wave length of the light as λ, and the order of interference between the plates at each reference mark as a_1, b_1, c_1, under one condition, and a_2, b_2, c_2, under a second condition. The absolute changes in the lengths of the pins are then:

$$\Delta A = \frac{\lambda}{2}(a_2 - a_1) \tag{1}$$

$$\Delta B = \frac{\lambda}{2}(b_2 - b_1) \tag{2}$$

$$\Delta C = \frac{\lambda}{2}(c_2 - c_1) \tag{3}$$

The changes in order $(a_2 - a_1)$, etc., can be obtained, from the displacement of the fringes past the reference marks or from the determination of the whole orders a_1, a_2, b_1, etc., by using the approximate length of the pins and the measured fractional orders due to several wave lengths, by the method described by Meggers,[3] which holds as well for straight fringes as for Haidinger's rings.

The relative or differential changes in the length of the pins can be determined from the differences in order at the reference marks. The quantity $(a_1 - b_1)$ is the difference in the orders between the plates at A and B under the first condition, and $(a_2 - b_2)$ is the difference in the orders at A and B under the second condition. These quantities are determined from the whole number of fringes and the measured fractions, between

[2] Zeitschr für Inst. 18:261. 1898.

[3] Bull. Bur. Stand. 12:203. 1915–16.

the reference marks at A and B. The change in these differences of order is then

$$(a_2 - b_2) - (a_1 - b_1)$$

and the relative change in the length of A and B is

$$\Delta A - \Delta B = \frac{\lambda}{2}[(a_2 - b_2) - (a_1 - b_1)] \tag{4}$$

Similarly, the relative change in the length of A and C is

$$\Delta A - \Delta C = \frac{\lambda}{2}[(a_2 - c_2) - (a_1 - c_1)]. \tag{5}$$

If ΔA is known or has been obtained from the determination of $(a_2 - a_1)$, equation (1), the value of B and C can be computed from these relations.

The arrangement of the apparatus just described was used at the Bureau of Standards to measure the differences in the thermal expansion of steel samples, and to determine the thermal expansions of steel, copper and brass simultaneously in the temperature interval of 0° to 100° C. It is now being used in the investigation of dental materials to determine the thermal expansion and the change in length while setting. The results of these investigations will be published in the Bulletin of the Bureau of Standards. This form of the apparatus is very easily made and adjusted. The pins can be cut out in a few minutes and their size measured with sufficient accuracy with a micrometer. They can be of almost any shape as long as the base is plane and the top is brought to a conical point. The reference marks can be drilled in the cover plate in a very short time and it is not at all necessary to know the distances between them. The fact that only a small area of the plates close to the reference marks and not a portion of the plates removed from the samples is used in making the measurements of the absolute change in length of the pins, eliminates the necessity of having the plates perfectly flat. They may be slightly concave or convex. The same thing holds for the relative determinations. The interference fringes denote the difference in separation of the plates at the reference marks, even though the intervening surfaces deviate slightly from true planes.

By using the Fizeau apparatus in the manner described in this paper the absolute change of length of one, two, or three small pins can be determined during one experiment. The exact change in each pin is determined and not the mean change of the three pins. The unequal change of similar pins is not important in most practical tests, but where precision is desired it is quite annoying. The differential changes in length of three pins can also be determined without knowing the absolute change of any of them.

As it is rather difficult to watch the displacement of the fringes past the three reference marks simultaneously, it is better to determine the absolute change in length of one pin by equation (1) and compute the values for the other two pins with equations (4) and (5). The results in either case are exactly the same because they depend upon the same measurements of the fractional orders. The accuracy of these results is limited only by the accuracy with which the fractional orders are determined.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

BOTANY.—*A botanical trip to Mexico.* A. S. HITCHCOCK. Sci. Monthly 8: 129–145, 216–338, pls. 34, maps 6. February, March, 1919.

An account is given of a trip made in 1910 for the purpose of studying and collecting grasses. A map showing the itinerary indicates that all the states north of the isthmus of Tehuantepec were visited except Sinaloa, Tlaxcala, and the territory of Tepic. There is a discussion of the topography (illustrated by a map), the rainfall (with a table and map showing the annual rainfall at representative stations, a map showing isohyets, a series of maps showing the annual rainfall by months), and the temperature. An account is given of the floral regions, the range conditions, and the forage crops.

Especial attention is given to the distribution of the grasses in relation to the floral regions, of which the most important are the eastern Coastal Plain, the western Coastal Plain, the Plateau, the slope from the Plateau to the Coastal Plain, the high mountains, and the ponds and marshes.

Orizaba was ascended to nearly 18,000 feet, Popocatepetl to snowline (about 15,000 feet), and Nevada de Colima to the summit (14,370 feet).

A. S. H.

ECONOMICS.—*Potato flour and potato bread.* J. A. LECLERC. The Potato Magazine. January and February, 1919.

This article compares the composition of potato and wheat flours and of breads made with a combination of 20 per cent of potato flour and 80 per cent wheat flour. It also shows how many pounds of the various food constituents of potato, potato flour, and of wheat flour can be obtained for one dollar with varying prices for these products. The amount of food constituents obtained from one acre of land grown to potatoes and to wheat is also given. Bread made with the use of potato flour as a part substitute is appreciably richer in mineral constituents than is white bread, but somewhat poorer in fat and protein.

With flour at $12.80 per barrel and potatoes at $1.75 per bushel, flour is a cheaper food than potatoes, and will furnish considerably more dry matter, protein, fat, and starch, and heat units for $1.00. On the other hand potatoes will furnish four times as much mineral ingredients as will the white flour for the same money. On the basis of average yields of 100 bushels of potatoes and 14 bushels of wheat per acre, one acre of land planted to potatoes will produce more food than in the form of wheat to the following extent: 36 lbs. of mineral constituents or a gain of 560 per cent; 28 lbs. of protein, a gain of 37 per cent; 437 lbs. of starch, a gain of 87 per cent; 848,000 calories, a gain of 76 per cent.

J. A. LeC.

TECHNOLOGY.—*The microstructural features of "flaky" steel.* Henry S. Rawdon. Bull. Amer. Inst. Mining Eng. No. 146, p. 183. 1919.

One of the most vital problems in the manufacture of steel is the occurrence of defects designated as "flakes." These spots are usually revealed, if present in steel, when the tension specimen is taken so that it represents the mechanical properties of the material in a direction at right angles to the direction of forging. Flakes constitute one of the most serious problems met with in the manufacture of large caliber guns. Their occurrence in chrome nickel steels of the type used for air-plane crank-shafts is also a serious problem. To the unaided eye, a "flake" appears in the fracture of a freshly broken test specimen as a silvery white, very coarsely crystalline area surrounded by metal having the normal appearance. Such areas vary in size from minute spots to those 1 cm. or more in diameter. Microscopic examination of numerous specimens showed that the coarsely crystalline appearance is a surface configuration only. The "flake" has no depth; the metal in such areas is refined to the same degree as throughout the body of the piece. Within the mass of the steel, flakes exist as intercrystalline discontinuities. They may be located by means of X-ray examinations and when the specimen is broken along the line of such discontinuities a typical flake is revealed. The discontinuities in the metal often enclose inclusions of a nonmetallic nature in the form of very thin films. This is not always the case, however, and while flakes appear to occur most readily in "dirty" steel, it is not safe to assume that the presence of inclusions necessitates the presence of flakes.

H. S. R.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

BIOLOGICAL SOCIETY OF WASHINGTON

The 594th regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, March 22, 1919, called to order at 8:00 p.m. by Vice-President N. HOLLISTER; 33 persons present.

The regular program was as follows:

J. W. GIDLEY: *Notice of a large canid from the Cumberland Cave deposits.* Mr. Gidley briefly referred to the discovery of these deposits in western Maryland through the digging of a railroad cut and to his explorations of them. He then described the remains of a large doglike animal found in them by him. He pointed out its relationships to modern wolves, coyotes, and to the doglike remains in the asphalt deposits of southern California.

A. C. BAKER: *Intermediates in the Aphididae and their relation to alternate hosts.* Rearing experiments have shown the existence of adult intermediate forms in all species studied carefully by the writer. These forms show modifications in nearly all important structural characters. They occur between the forms on one host and between the forms on a primary and a secondary host. Thus they indicate the ultimate division of species, such as the latter, into two. In fact, almost, this occurred in the experiments. Host races were developed with such species as *Aphis rumicis*. These races differed in structure, after 50 generations or more, and individuals of them nearly all died when transferred to the host of their ancestors.

Our American species of *Anoecia* on *Cornus* compared with specimens from different parts of Europe (from H. SCHOUTEDEN, ALBERT TULLGREN, and others) differs in sensory organs. Our species, as reared, never developed the European characters. In most cases it became modified in the opposite direction. Races were developed which live the year round on grass roots, laying their winter eggs there. These forms differed very distinctly in structure from those including *Cornus* in their host cycle. In some sections of the country these, or similar races, seem to be settled as definite species with definite structure and definite reproductive and host habits. In our classifica-

tions we have no names for these potential species. In some cases it is necessary to rear very large numbers to determine the connection between forms existing in nature and it would seem advisable to have some designation for such groups of individuals.

The family seems to be in a more or less pliable state and these cases which we are able to observe may indicate the method by which different forms have come into existence and possibly some of the methods by which species fixation has taken place.

Discussion by Dr. L. O. Howard and S. A. Rohwer.

R. H. True: *Bernardin de Saint-Pierre as a plant ecologist.* The author of "Paul and Virginia" wrote a three-volumed book, entitled "Studies of Nature," intended to prove to a world that was lapsing into atheism that a beneficent Providence rules the affairs of men and of Nature. In this effort he studies the relations of plants to the main factors of their environment. He groups plants into two great classes, those enjoying a limited water supply, the mountain plants, and those whose supply is not limited, those of the plain, marsh, and riversides. Devices for collecting or shedding water are traced in foliage and stem. Flowers are dealt with in relation to light and heat, seeds and fruits to means of securing distribution. Many practical relations are discussed such as forest planting to increase rainfall, and the relation of stock grazing to forest injury. He deals with his evidence in a teleological spirit, oftentimes proving too much, but writing always with vivacity, clearness, and charm. As "nature writing," his work is worthy of attention from this later generation. It should not be neglected by plant ecologists and naturalists.

M. W. Lyon, Jr., *Recording Secretary.*

GEOLOGICAL SOCIETY OF WASHINGTON

The 330th meeting was held at the Cosmos Club, Wednesday evening, January 22, 1919, President Ulrich presiding, and 60 persons present.

The meeting was a memorial to Grove Karl Gilbert. After introductory remarks by President Ulrich, the following program was presented:

Biographical outline.......................... W. C. Mendenhall
Gilbert in his administrative relations.............. C. D. Walcott (read by E. O. Ulrich)
Gilbert as the student and expounder of geologic structure .... F. L. Ransome
Gilbert the physiographer and explorer............ H. E. Gregory
Gilbert the glaciologist............................ W. C. Alden
Gilbert the physicist and mathematician.......... R. S. Woodward
Gilbert the topographer.. J. H. Renshawe (read by E. O. Ulrich)
Gilbert as a man.......................... C. Hart Merriam
Personal reminiscences.... C. D. White, H. C. Rizer, and J. S. Diller

The 331st meeting of the society was held at the Cosmos Club on Wednesday evening, February 12, 1919, President E. O. Ulrich, presiding, and 74 persons present.

INFORMAL COMMUNICATIONS

T. W. VAUGHN: *Correlation of Tertiary formations on the perimeter of the Carribean Sea.*

R. S. BASSLER: *Quartz from Waynesboro formation crystallizing with three-faced terminal pyramid and used for correlation.*

REGULAR PROGRAM

RALPH ARNOLD: *The economic value of paleontology.*

E. W. SHAW: *Stratigraphy of the Gulf Coastal Plain as related to salt domes.*

This paper being in a way introductory to the following paper on the program has to do primarily with those features of the stratigraphy that are of principal interest in the study of salt domes. The more significant of these features relate to the age and thickness of the formations, and to the rigidity, chemical nature, and specific gravity of the materials composing them.

As is well known the formations are of Mesozoic and Cenozoic age and with the exception of the Jurassic most of the main divisions of these eras are known to be represented by deposits. Perhaps the divisions of the Cenozoic are more fully represented than those of the Mesozoic.

The aggregate thickness of the Cenozoic is commonly between 5000 and 7000 feet, the Eocene being 2500 to 3000, Oligocene and Miocene 2000 to 2500, and the Pliocene and Quaternary from 1000 to 3000. The upper Cretaceous seems to have the thickness ranging from 1500 to 2500 and the lower Cretaceous, where present, from a feather edge to about a thousand feet. Over a large area in coastal Louisiana and Texas the aggregate thickness of the various Cretaceous, Tertiary, and Quaternary formations probably ranges between 8000 and 12,000 feet and may average about 10,000 feet.

Apparently most of formations thicken somewhat toward the coast but the average or aggregate amount of thickening is unknown. To the east there is a notable thinning and rise of certain formations at least; beds lying at a depth of 2000 feet near Mobile lie at far greater depths two hundred miles to the west and a similar distance from the coast.

The age and nature of the materials underlying the Cretaceous along the Gulf Coast can only be conjectured. Knowledge concerning these materials and in particular as to whether or not they include beds or masses of salt and intrusions of igneous rock might be of considerable assistance in solving the salt dome problem. In central and western Texas the Triassic and Permian beds are many hundred feet thick and are salt bearing but they dip to the west and without reversal can not be present in Louisiana. Neither this nor any other known fact proves that there are no Permian or Triassic salt beds under Louisiana, but on the other hand the only reason for suspecting that they are present is the conclusion that the salt, gypsum, dolomite, sulphur, and other mineral matter in the salt dome came from below and the fact that such mineral matter is perhaps more common in the Permian and Tri-

assic than in any other group of beds. The copper and other metallic minerals, small quantities of which have been reported at one or two places, harmonize with the hypothesis.

The lithologic features of the Cretaceous and Tertiary that are of special interest in the salt-dome problem are the generally more clayey and apparently also more carbonaceous constitution of the material west of the Mississippi as compared with that to the east. Apparently the salt domes occur where the beds are thicker, softer, and more carbonaceous, and the writer suspects that there is some relation between these characteristics of the region and the domes. There are, of course, a good many more or less thoroughly indurated beds including chalk and limestone west of the Mississippi, particularly in the older formations, but the mass of Mesozoic and Cenozoic materials as a whole seems to be of a conspicuously yielding nature.

The great thickness and the low degree of rigidity are apparently related to a westward littoral current which, though not strong enough to carry sand except along the strand, has for ages carried very fine-grained and clayey material westward from the mouths of the Mississippi and other ancestral and present-day rivers discharging from the central and eastern portion of the Gulf embayment. The most striking general feature of the samples that I collected on the Fish Hawk expedition, a few years ago, is the contrast between the dark and clayey sea-bottom material west of the Mississippi and the lighter-colored and coarser-grained material to the east.

Since the deposits are mainly unconsolidated and many layers are plastic it seems presumable that in the process of intrusion, differences in specific gravity between intruding and intended materials will control to a more or less notable degree the form of the intrusion. For example it seems quite possible, if not probable, that if a rising mass of salt or one of molten rock comes to a position where the overlying material weighs less per cubic foot than the rising mass, the mass may cease rising and may even "mushroom," whereas if the overburden were heavier the intrusion might continue to rise and might even develop into an extrusion. The clay and incoherent sand of the gulf coast have an average specific gravity including the water in their pores of about two (probably somewhat less than two) and therefore are a little lighter than salt and much lighter than igneous rock. Hence the absence of igneous rock at the surface cannot be taken as an indication that the salt domes have not formed over igneous plugs.

Another way that differential specific gravity may play a part in the growth of salt domes is based on the fact that the hydrostatic head at any point underground is only about half the weight of overlying deposits. Assume a bed of salt with a perfectly smooth top lying at a depth of 10,000 feet and upon this salt a bed of sand with interstices filled with water which, by way of connecting interstices, forms a continuous column up to the surface of ground water. Where the grains of sand rest upon it the salt supports a pressure about 8000

pounds to the square inch. Where the water rests upon it the pressure is only about half as great. Salt being somewhat plastic the difference in pressure would no doubt cause the sand grains to sink into the salt and the salt to rise between sand grains until friction put an end to the adjusting process, which might be in a fraction of an inch.

Now suppose a rising igneous plug approaches the salt bed and raises the temperature until, with whatever aid may be rendered by the ever-present water, it melts the salt. The process outlined above would then proceed to a much greater extent, the salt rising like so much water until the supply near enough the plug to be melted was exhausted. Apparently the process might involve the pushing aside of a large body of sand and other materials and the development of a considerable mass of salt, accompanied by unusual secondary deposits due to the unusually high temperatures.

G. S. ROGERS· *Origin of the salt domes of the Gulf Coast.* The origin of the great plugs of salt that occur here and there beneath the Coastal Plain of Texas and Louisiana is an obscure problem which has been a subject of much speculation. The small diameter of these plugs and their great depth (at least 5,400 feet in once case) indicate that they are not original bedded deposits. Nearly all American writers have adopted the view that the salt has been deposited by ascending brines, but the plausibility of this theory is injured by the stupendous quantity of brine involved, for no likely condition has been suggested under which the waters would deposit more than a fraction of their dissolved load.

Although direct evidence of the mode of formation of the salt plugs is scanty, there are several indications that positive tectonic forces have been involved. The plugs are arranged rather regularly along lines that are undoubtedly related to the main structural features of the region. Moreover, the plugs have caused a sharp and very local upthrust or doming of the normally flat-lying sediments, the uplift in some cases amounting to at least 3000 feet. The surface beds may be only slightly disturbed, if at all, but down on the flanks of the salt mass dips of 60° or more are common and in some cases formations have been thrust clear through the beds that normally overlie them. Still more direct evidence is afforded by the structure of the salt itself; as seen in the mines the salt contains dark streaks which, though commonly standing almost vertical, are in places thrown into intricate folds which bear an extraordinary resemblance to the flow structure of ancient rocks. The common elongation of the salt crystals in a vertical direction and the rough horizontal cleavage of the salt also suggest vertical movement.

Laboratory experiments have shown that salt under differential pressure behaves as a highly plastic substance; that its plasticity is increased by heat; and that if shattered it is easily welded by pressure. In view of the field evidence cited, the writer believes that the salt plugs are offshoots of deeply buried bedded deposits which have been subjected to great pressure or thrust, and have been partially squeezed upward in a semiplastic condition along lines of weakness. As the

region lies along a heavily loaded sea coast, the nature of the lateral thrust is not difficult to understand. The fact that the surface beds are undisturbed, except immediately around the salt plugs, is explained by the nature of the section—a series of indurated and rigid formations overlain by a great thickness of relatively yielding and plastic sediments. Indirect evidence of the origin of the plugs is also afforded by their identity in structure and composition with the European salt stocks, the tectonic origin of which is declared to be unmistakable.

The 332nd meeting of the Society was held in the Cosmos Club Wednesday evening, March 12, 1919, President ULRICH presiding and 46 persons present.

INFORMAL COMMUNICATIONS

G. W. STOSE: *Travertine from Rock Creek Park, District of Columbia.* Travertine occurring in a granite country would seem to be unusual, but travertine has recently been found on the granite and schist in Rock Creek Park, near Blagden Mill road. This deposit of aragonite travertine occurs at the mouth of an apparently large spring which empties into Rock Creek. On investigation the spring proved to be an overflow from a nearby city reservoir. It seems therefore that the travertine deposit came from lime dissolved out of the cement in the masonry of this reservoir and its conduit.

In discussing Mr. Stose's paper, R. S. BASSLER, of the National Museum, called attention to the deposit of calcareous stalactites in a culvert under the aqueduct along Potomac River in the District of Columbia. These stalactites are derived from lime used in the masonry of the aqueduct, and a new crop is found on each annual visit of a class in geology.

R. B. SOSMAN: *The temperature inversions in the fumaroles of the Valley of Ten Thousand Smokes, Alaska Peninsula.* The peculiar inversion of temperatures in the fumaroles of the Valley, which was discovered in 1918 and reported by Prof. R. F. GRIGGS in his lecture before the Washington Academy of Sciences on February 18, 1919, and which seemed at first the most puzzling feature of the fumaroles, may find explanation in the "velocity cooling" which is known to occur in a jet of gas issuing from an orifice. It has been observed experimentally by Joule and Thomson[1] and by Bradley and Hale[2] in high-pressure air jets, and is discussed by S. A. Moss[3] in connection with experiments on steam flowing from orifices. The cooling effect is due to the conversion of heat energy into translational kinetic energy, which is subsequently converted back into heat when the high-velocity jet of steam is checked. We have here the possibility that the apparent temperature of a jet, as measured by a thermometer, will show variations with the shape and size of the thermometer.

[1] JOULE and THOMSON. Phil. Mag. (4) 4: 491. 1852.

[2] BRADLEY, W. P., and HALE, C. F. Phys. Rev. 29: 266. 1909.

[3] MOSS, S. A Trans. Amer. Soc. Mech. Eng. 38: 766. 1916.

The temperature differences found by measurements at different levels in the fumaroles of the Valley are, however, on a larger scale than any that are ordinarily observable experimentally, and it is still possible that some other factor may be active in addition to the velocity cooling.

T. W. VAUGHN: *Note on Eocene corals from Peru and on other fossils from Haiti and Trinidad.*

REGULAR PROGRAM

F. E. MATTHES: *Relief shading of topographic maps.* The most difficult thing which cartographers and topographers have to deal with is representing the vertical element in the delineation of land features. This delineation can be done in several ways as by hachuring, contouring, and by shading. Hachuring has been developed to an art in Europe. It requires a draftsman with a steady nerve and hand, and the reproduction of his work by expert engravers. The art had reached fine execution by 1815, yet in Europe, long ago, hachuring was replaced by shading. The same effect is obtained with perhaps one-twentieth the cost. Shading represents land forms perhaps more adequately than hachuring and can be used to better advantage and more generally than hachuring.

For the last three decades in the United States we have devoted our energy almost exclusively to contouring. No country has done better, but we have used contours where their use was at a disadvantage. Delineation of land forms has been attempted also by hypometric tints but these must be based primarily on contour work. It is a good practice for hachuring and shading to be done as if a relief model were hung vertically on a wall and illuminated above and to the left. In experimental work done by J. H. Renshawe, of the U. S. Geological Survey, this lighting element has been employed but Mr. Renshawe has developed one method different from that of European topographers, in that dark shading is used to express the lowest altitude of river areas, whereas in European maps lowlands are lighter and high plateaus are dark. On shaded maps made recently by the U. S. Geological Survey, high plateaus are given a light shading and flat areas close to sea level are given a deep shading. This obviates confusion found on European maps in which both the mountain tops and the valley bottoms are given the same high light.

O. E. MEINZER: *Quantitative methods for estimating ground-water supplies.* This paper relates only to *ground water*, or *phreatic water*—that is, water in the zone of saturation. It is not concerned with the subsurface water that occurs above the water table. It relates not to the quantities of water stored in the earth but to the rate of replenishment of the ground-water supply, on which conservation developments must be based.

Four principal groups of methods are used to determine the annual recharge or the "safe yield" of ground water: the Intake, Discharge, Water-table, and Underflow methods. The first of these consists in

measuring the quantity of surface water that seeps into the earth and percolates into the zone of saturation; the second in measuring the ground water that is discharged through springs, or by evaporation from soil and plants; the third in observing the fluctuations in the water table, which represents filling or emptying of the ground-water reservoir; the fourth, like the gaging of surface streams, in measuring the flow of ground water at selected cross-sections.

Discharge methods comprise two very different kinds of methods: (1) the differentiation of ground-water run-off from direct run-off through study of hydrographs, etc., and (2) the mapping of areas that discharge ground water by evaporation and transpiration, and experiments to determine rates of discharge under specific conditions of soil, vegetation and depth to water table. In arid regions plants of certain species habitually utilize water from the zone of saturation. For such plants the name *phreatophyte*, meaning a "well plant," has been proposed.

The water-table methods are best adapted to regions, such as California, which have well-defined rainy and dry seasons. The average annual increment to the ground-water supply can be computed by multiplying the average rise of the water table in the rainy season by the percentage of available pore space, and multiplying this product by the area of the water table of the given aquifer. The most uncertain factor is the percentage of available pore space, or *specific yield*, which is not the same as the porosity of the rock, because when the water table descends some of the water is held against the pull of gravity by the molecular attraction of the rock. Tests of specific yield have been made (1) by laboratory experiments; (2) by examination of samples of material which is above the water table but which in the high-water stage was in the zone of saturation; and (3) by making heavy pumping tests and ascertaining the total pumpage and the total volume of sediments drained thereby.

The two lines along which additional research are most needed relate to the habits of phreatophytes and their rates of transpiration and to the specific yields of different kinds of sediments. A very fortunate feature of the quantitative work is that the three principal methods—intake, discharge, and water-table—are entirely independent of each other and can be used as checks upon one another.

The 333rd meeting of the Society was held at the Cosmos Club on Wednesday evening, March 26, 1919, President ULRICH presiding, and 48 persons present.

INFORMAL COMMUNICATIONS

F. L. HESS: *Phenocrysts in granitic intrusions.* Deposits of rare metals are commonly connected with granites and are usually in the outer parts of granitic intrusions, and it thus happens that many of the deposits are accompanied by extraordinary forms of the granite. Close to the cobalt deposits on Blackbird Creek in Lemhi County, Idaho, a remarkable porphyritic granite is found on Big and Napias Creeks. The

phenocrysts are speroidal or elliptical and as much as three inches long by two inches in diameter. They weather out and look like rounded pebbles. The main intrusion is exposed for about three miles along the creek but it is not known at what angle the creek cuts the dike. Smaller dikes are from fifty to several hundred feet broad and all are crushed to gneisses along their sides.

D. E. WINCHESTER: *Contorted bituminous shale of Green River formation in Northwestern Colorado.* In the upper part of the oil shale series of northwestern Colorado there is a zone of rich black bituminous shale which is everywhere contorted showing on its weathered surface minute folding and faulting. This shale which has been observed over a wide area is overlain and underlain by beds of laminated and uncontorted shale and sandstone. The bituminous shale itself contains a large amount of microscopic vegetable material, including algae, etc., and this may furnish a clue as to the reason for its contorted condition. The region is one in which there is practically no faulting, and beds dipping as much as 15° are the exception rather than the rule. It is concluded that the twisting of the laminae occurred before the bituminous shale was completely solidified and that the beds containing the great amount of vegetable matter were least competent and may therefore have taken up any movements which may have occurred in the region. Specimens of thinly laminated shale rich in organic matter but occurring at a horizon 300–500 feet below the black contorted beds, show intricate folding and minute faulting.

Discussion; E. O. ULRICH: The same contorted condition of thin beds can be seen in mud laid down on tidal flats and then slumped by tidal undercutting. It is shown also in West Canada Creek at Trenton Falls, New York, where the limestone, once a limy mud, has these features. C. D. WHITE: Green River beds essentially horizontal are a good place to see thin contorted strata. The contorted beds are buried beneath shale and sandstone. It would seem that the organic beds between sandstones must have been slimy mud a long time after burial and even if somewhat hardened must have been the easiest zone for slipping. They doubtless were somewhat solidified when the crumbling took place else there would be no faulting. Possibly the shale exhibited by Winchester was deeply buried and the contortion is due to movement along the oil shales after they were partly solidified. The overlying and underlying formations have a somewhat reinforced structure and slight jars or lesser earth movements would be taken up by oil shale beds which are rich in vegetal matter. Similar structure is found in the Elkhorn coal on Marrowbone Creek in eastern Kentucky, where the upper part of the coal bed moved on the lower part. W. C. ALDEN: This kind of structure is common in glacial lake beds where we find zones a few inches thick highly contorted, while above and below are beds clearly and beautifully laminated, which show no disturbance. It is suggested that the contortion may be due to freezing before the superincumbent layers were deposited. G. H. ASHLEY: In northern Indiana the plankton found in the small lakes resembles in structure the

shale shown by Winchester. This jelly-like material moves with the movement of the water. Storms move the water-weeds and the light floating jelly-like stuff may be moved at the same time, and rumpled.

REGULAR PROGRAM

ROBERT B. SOSMAN: *Note on volcanic explosions.* The usual conception of a volcanic explosion is that of the release of a store of pent-up energy which has been held in a confined space by external pressure. The idea takes two forms: (1) The "boiler explosion," in which the pressure has been raised by heat to a value which exceeds the breaking strength of the containing rocks; or, (2) the "geyser eruption," in which a metastable configuration of the materials of the volcano has been disturbed and a violent reaction has begun. In either case, the conception is that of a system in rapid reaction in an effort to reach equilibrium, following some change in external conditions.

An experiment by the speaker, made several years ago, showed that finely divided alumina, which is well known to be very hygroscopic, could be superheated in an open electric furnace and then be "exploded" by a mechanical disturbance. The phenomenon is strikingly analogous to the dust explosions of Lassen Peak and Mont Pelée.

The steam boiler and the geyser may be called "explosive systems." Another class of explosions results from the initiation of chemical reactions in "explosive mixtures," such as gunpowder, or a mixture of sulfur and potassium chlorate. It seems unlikely that many volcanic explosions can be of this character, on account of the difficulty of accumulating the necessarily large quantities of substances capable of reacting (such as oxygen and hydrogen), without the dissipation of the energy by continuous quiet reaction, as at Kilauea.

In a third class are the "explosive substances," of which nitroglycerin is the most powerful common representative. These explode by internal disintegration and recombination, and can be "detonated" by methods other than simple rise of temperature. Organic dust (flour, coal) with oxygen and moisture adsorbed on the surfaces of its grains is, to all intents and purposes, a chemical compound and an explosive substance, though of a milder type than the nitro-compounds; and even inorganic dust with adsorbed moisture, such as the alumina in the experiment cited, is, analogously, an explosive. It is suggested that dust explosions of the Peléean type, which are often plainly superficial and not deep-seated, are true explosions, possibly set off by mechanical disturbances. The same may be true of Vulcanian and Plinian explosions, the explosive in these cases being a metastable liquid silicate or a mixture of liquid and solid silicates, brought into its metastable condition by a gradual rise of temperature or by the gradual accumulation of water or magmatic gases, either through distillation or through fractional crystallization. The specific character of the shock necessary to detonate an explosive substance; the limited range of propagation of the explosive wave in a powdered material, as contrasted with the more complete detonation which can be brought about in a continuous

liquid or solid explosive; and the fact that the force of a detonated explosion is often in the direction of the detonating impulse and independent of the configuration of surrounding materials (Pelée, Lassen); are all applicable to the explanation of known phenomena of volcanic explosions.

E. O. ULRICH: *Newly discovered instances of early Paleozoic oscillations.* Anyone who will undertake a comprehensive course of critical and detailed comparison of stratigraphic sections must inevitably reach the conclusion that the old land surface was exceedingly unstable with respect to sea level and subject to oft-repeated differential movements and warping.

At times certain parts were pushed up, while other parts lagged, and yet others sank, actually or but relatively, beneath sea level. In other words, the vertical movements of the lithosphere were differential, and the displacements of the strandline were not erestatic, as taught by Suess, but varied in volume and direction from place to place.

The differential character of the movements of the continental areas with respect to sea level is indicated by abrupt local, or even widely distributed changes in the character of the sediments; by imperfections in the record of marine deposits at one place which are partly and sometimes, perhaps, wholly supplied in the sedimentary record at another place; by the sudden extinction of, say, an Atlantic fauna in a given area by a Gulf of Mexico or an Arctic fauna; and by other more or less competent criteria.

Most convincing evidence of land tilting, with alternating east and west tilts more common than those to the south or north, was brought out by *detailed* comparisons of the sedimentary record on the flanks of old uplifts in interior North America. Particularly illuminating are the facts showing restriction of formations of considerable thickness to one side of such uplifts and similar restriction of other formations to the opposite side. Geographic restriction of deposits, hence also of the seas in which they were laid down, is indicated over and over again on the flanks of the Cincinnati, Nashville, Ozark, Wisconsin, and Adirondacks domes. These domelike areas rarely, if ever, formed islands. As a rule, when they were not completely submerged, they were connected with larger land areas, often probably forming peninsular projections.

Oscillation of land and sea areas was the rule also in the Paleozoic Appalachian Valley. However, the conditions here differed in that the seas were largely confined to subparallel structural troughs. These troughs were not all submerged at the same time; and only very seldom was any one of the five or six troughs submerged throughout its length. As a rule tilting, or differential movements, produced canoe-like depressions which, when they reached depths permitting marine submergence, formed narrow inland bays. These bays were emptied and again filled many times, and each submergence differed more or less in its geographic expression from those preceding it.

The old belief in broad, deep, and long enduring continental seas—seas that began early in the Cambrian and continued spreading wider and wider until well toward the close of the Ordovician—is still held and taught in some of our best universities. But this inexcusable conservatism is possible only by closing our eyes to the overwhelming accumulation of opposing facts. Sooner or later it must be abandoned by all. In its place the more progressive geologists conceive of smaller, very shallow, and frequently shifting bodies of water, of seas, that filled a given basin in one age and were withdrawn in the next, that returned again and again in familiar patterns, though perchance from different quarters, in succeeding geological ages. In short, seas that migrated in and out of the structural basins—sometimes extending far across the continents and at other times limited to much smaller areas—whenever and wherever a formation of the lithosphere demanded corresponding readjustment of land and marine areas. These adjustments were always marked in the stratigraphic record by recognizable signs.

Each year's field work is disclosing evidence of Paleozoic oscillations previously unknown; and some of them occur in what had seemed altogether unlikely places. The purpose of my paper is to discuss a half dozen or so of the more striking instances that have been discovered since the publication of the "Revision." The first of these is found in central Pennsylvania, the second and third in east Tennessee, the fourth in northeastern Alabama, the fifth in Wisconsin, the sixth in the Mississippi Valley. In the last two the formations lie practically horizontal, in the others they are folded in the usual Appalachian manner.

R. W. STONE, *Secretary*.

SCIENTIFIC NOTES AND NEWS

The organization meeting of the American Society of Mammalogists was held in the New National Museum, Washington, D. C., April 3 and 4, 1919, with a charter membership of over two hundred and fifty, of whom sixty were in attendance at the meeting. The following officers were elected: C. Hart Merriam, *President;* E. W. Nelson, *First Vice-President;* Wilfred H. Osgood, *Second Vice-President;* H. H. Lane, *Recording Secretary;* Harley H. T. Jackson, *Corresponding Secretary;* Walter P. Taylor, *Treasurer.* The *Councilors* are: Glover M. Allen, R. M. Anderson, J. Grinnell, M. W. Lyon, W. D. Matthew, John C. Merriam, Gerrit S. Miller, Jr., T. S. Palmer, Edward A. Preble, Witmer Stone, and N. Hollister, *Editor*.

Committees were appointed on: *Life histories of mammals*, C. C. Adams, *Chairman; Study of game mammals*, Charles Sheldon, *Chairman; Anatomy and phylogeny*, W. K. Gregory, *Chairman;* and *Bibliography*, T. S. Palmer, *Chairman.*

The policy of the society will be to devote its attention to the study of mammals in a broad way, including life histories, habits, relations to plants and animals, evolution, paleontology, anatomy, and other phases.

Publication of the Journal of Mammalogy, in which popular as well as technical matter will be presented, will start this year.

At the meeting of the National Academy of Sciences held in Washington on April 28–30, 1919, the following fifteen persons were elected to membership: Prof. Joseph Barrell, geologist, Yale University; Dr. Gary Nathan Calkins, zoologist, Columbia University; Dr. Heber Doust Curtis, astronomer, Lick Observatory; Mr. Gano Dunn, electrical engineer, New York City; Dr. Lawrence Joseph Henderson, biologist, Harvard University; Dr. Reid Hunt, pharmacologist, Harvard University; Prof. Treat Baldwin Johnson, chemist, Yale University; Prof. Winthrop John Osterhout, botanist, Harvard University; Prof. Frederick Hanley Seares, astronomer, Mt. Wilson Observatory, California; Dr. William Albert Setchell, botanist, University of California; Maj. Gen. George Owen Squier, electrical engineer, Signal Corps, U. S. A.; Prof. Augustus Trowbridge, physicist, Princeton University; Prof. Oswald Veblen, mathematician, Princeton University; Dr. Ernest Julius Wilczynski, mathematician, University of Chicago; Prof. Edwin Bidwell Wilson, physicist, Massachusetts Institute of Technology. Dr. C. G. Abbot was elected Home Secretary of the Academy.

Rear Admiral JOHN E. PILLSBURY, U. S. N., Retired, was elected President of the National Geographic Society on April 17, as successor to Mr. OTTO H. TITTMANN, who retired from the office on account of ill health. Rear Admiral ROBERT E. PEARY, U. S. N., Retired, was elected a member of the Board of Managers to fill the vacancy caused by the death of the late Brig. Gen. JOHN M. WILSON, U. S. A.

Dr. C. G. ABBOT, of the Astrophysical Observatory, Smithsonian Institution, sailed for South America on May 1 to inspect the Smithsonian solar constant observing station at Calama, Chile, and to observe the total solar eclipse at La Paz, Bolivia. He expects to return to Washington in August.

Prof. J. M. ALDRICH has been appointed Associate Curator of the Division of Insects in the National Museum. Prof. Aldrich was formerly with the University of Idaho, but more recently has been working with the Bureau of Entomology. He is one of the best-known Dipterists in North America and is the author of our most recent catalogue of these insects.

Dr. GEORGE FERDINAND BECKER, geologist in charge of the division of physics and chemistry, U. S. Geological Survey, and a charter member of the ACADEMY, died on April 20, 1919, in his seventy-third year. Dr. Becker was born in New York City on January 5, 1847. He began work as a constructing engineer, with the Joliet Iron and Steel Company, then after a few years became instructor in mining and metallurgy at the University of California. He was appointed geologist in the U. S. Geological Survey in 1879, and was thus associated with the development of the Survey almost from its beginning. He approached geologic problems from the viewpoint of the mathematical physicist and engineer, and made many contributions to geophysics, as well as to special fields in both physics and geology. The establishment of the Geophysical Laboratory of the Carnegie Institution grew out of investigations begun by him under a grant from that Institution. He was a member of the National Academy of Sciences, the Geological Society of Washington, and other American geological and engineering societies, including the Geological Society of America of which he was president in 1914.

Dr. F. RUSSELL v. BICHOWSKY, of the Geophysical Laboratory, has been granted by the National Research Fellowship Board a research fellowship in chemistry at the University of California.

E. D. BROMLEY, of the U. S. Coast and Geodetic Survey, has been engaged in a triangulation in the northern half of Chesapeake Bay, to determine the geographic positions of certain points used in testing the long-range artillery at Aberdeen, Maryland.

Dr. KEIVIN BURNS, of the division of optics, Bureau of Standards, resigned from the Bureau on May 1. He will spend a year on the Pacific Coast and will devote his attention to the use of dicyanin in astrophysical research.

Mr. J. C. CRAWFORD, formerly Associate Curator of the Division of Insects of the National Museum, has resigned and accepted a position in the Bureau of Entomology.

Captain S. T. DANA has resumed his duties with the Forest Service as Assistant Chief of Forest Investigations. During the war he was on the General Staff as secretary of the Army Commodity Committee on Lumber, and in charge of determining wood requirements of the Army.

Col. E. LESTER JONES, Superintendent of the U. S. Coast and Geodetic Survey, has been named by the King of Italy an officer of the Order of S. S. Maurizo e Lazzaro.

Dr. LEONARD B. LOEB, formerly of the Bureau of Standards, has been granted a research fellowship in physics by the National Research Fellowship Board.

Major A. O. LEUSCHNER has returned to Washington from a furlough in California and is at present acting chairman of the Division of Physical Sciences of the National Research Council.

Dr. SAMUEL C. PRESCOTT, of the Massachusetts Institute of Technology, formerly major in the Sanitary Corps, U. S. A., has been appointed expert in charge of dehydration investigations in the Bureau of Chemistry, Department of Agriculture, and will continue the investigations on this subject carried on during the war under the direction of the War Department.

Mr. HOMER P. RITTER, for many years an officer of the U. S. Coast and Geodetic Survey and a member of the Mississippi River Commission, died at the Emergency Hospital on April 21, 1919, in his sixty-fifth year. He was returning from a meeting of the Mississippi River Commission at Memphis and was taken ill on the train. Mr. Ritter was born in Cleveland, Ohio, March 4, 1855. After receiving his technical training at the Columbia School of Mines he was employed for several years on railway surveys. He entered the Coast and Geodetic Survey in 1885, and had been employed on field work in all parts of the United States and in Alaska. He succeeded HENRY L. MARINDIN as a member of the Mississippi River Commission in 1904. He was a member of the Society of Engineers.

Mr. R. SANO, founder and director of the meteorological observatory of Kanayama, near Sendai, Japan, visited Washington in April.

Mr. A. H. SMITH, of the rubber laboratory, Bureau of Standards, will leave the Bureau on July 1, to accept a position with the Goodyear Rubber Company, at Akron, Ohio.

Mr. WM. SCHAUS has recently been appointed as Assistant Curator in the Division of Insects of the National Museum. Mr. Schaus is a student of Lepidoptera and in recent years has spent much time in tropical America where he made large collections which have been given to the National Museum.

Dr. C. H. T. TOWNSEND sailed, early in April, for Brazil where he has accepted a position as entomologist for the Brazilian government. Dr. Townsend has been with the Bureau of Entomology and has spent most of his time studying the Muscoid Diptera.

A Washington Section of the American Society of Mechanical Engineers has been organized, with the following officers: S. W. STRATTON, Bureau of Standards, chairman; Maj. J. H. KLINCK, vice-chairman; Prof. GEO. A. WESCHLER, Catholic University, secretary; H. L. WHITTEMORE and A. E. JOHNSON, members of executive committee. The Section held a meeting with the following program: S. W. STRATTON, *Standardization of screw threads;* Col. E. C. PECK, *Gage work of the Ordnance Department for the U. S. Army;* H. L. VAN KEUREN, *Certification of gages at the Bureau of Standards;* C. G. PETERS, *The use of interference methods in calibrating length standards.*

The Medical Society of the District of Columbia, one of the affiliated societies of the ACADEMY, is raising a fund of $100,000 for the erection of a permanent home for the Society. A site on M street near Connecticut Avenue has already been purchased. Dr. EDWARD Y. DAVIDSON is chairman of the building committee.

NATIONAL RESEARCH COUNCIL

One year ago this JOURNAL[1] outlined the war reorganization of the National Research Council which went into effect on April 1, 1918. With the coming of peace this plan of organization has been elaborated and the Council placed on a continuing basis. The present organization was adopted on February 11, 1919, by the council of the National Academy of Sciences, and is, in brief outline, as follows:

The membership is to consist of: (1) Representatives of national scientific and technical societies; (2) representatives of the federal government; (3) representatives of other research organizations, and other persons whose aid may advance the objects of the Council. The membership is organized into thirteen divisions, grouped into two classes, as below:

(a) Divisions dealing with general relations: I, Government Division. II, Foreign Relations. III, States Relations. IV, Educational Relations. V, Industrial Relations. VI, Research Information Service.[2]

(b) Divisions of science and technology: VII, Physical Sciences. VIII, Engineering. IX, Chemistry and Chemical Technology. X, Geology and Geography. XI, Medical Sciences. XII, Biology and Agriculture. XIII, Anthropology and Psychology.

Each division in the class of science and technology, and some of the divisions in the class of general relations, will have a salaried chairman, who will be stationed in Washington. The affairs of the Council will be administered by an executive board, which will include, in addition to *ex-officio* members from the Council itself, the President and Home Secretary of the National Academy and the President of the American Association for the Advancement of Science. The Chairman of the

[1] This JOURNAL 8: 337. 1918.

[2] See this JOURNAL 8: 223, 339. 1918.

Council will receive a salary of \$10,000 per year, and the chairmen of divisions, as well as the executive secretary of the Council, will receive \$6000.

Prof. J. C. MERRIAM, of the University of California, is at present Acting Chairman of the Council. Officers of some of the divisions have been selected as follows: Physical Sciences, Maj. C. E. MENDENHALL, chairman; Engineering, Dr. H. M. HOWE, chairman, Mr. G. H. CLEVENGER, vice-chairman; Chemistry and Chemical Technology, Lieut. Col. W. D. BANCROFT, chairman, Prof. JULIUS STIEGLITZ, vice-chairman; Biology and Agriculture, Prof. C. E. MCCLUNG, chairman, Prof. L. R. JONES, vice-chairman.

Further information on the organization of the Council will be presented as soon as the organization is completed.

UNION OF SCIENTIFIC AND TECHNICAL WORKERS

A mass meeting of scientific and technical employees of the federal Government, called by a committee consisting of H. L. SHANTZ (Agriculture), W. L. THURBER (Interior), L. W. CHANEY (Labor), P. G. AGNEW (Commerce), and F. L. LEWTON (Smithsonian), was held at the National Museum on Thursday, May 8, 1919. The attendance was about 400. R. H. TRUE, of the Department of Agriculture, presided. The call for the meeting stated the following reasons for the formation of an organization:

Improvement of conditions and facilities for more effective scientific and technical work; adequate presentation of the needs and results of such work to the public and to legislative and administrative officers; greater freedom in both official and non-official activities, just and reasonable salaries based on service performed and the economic and social conditions which prevail, greater public recognition of the aims and purposes of research; advancement of science and technology as an essential element of national life.

After a statement concerning the British National Union of Scientific Workers and similar movements in Great Britain, the following three plans were discussed:

(1) To work only through existing organizations, namely, the ACADEMY and the National Research Council; (2) to form an independent organization of those federal employees doing scientific or technical work, (3) to form a scientific and technical branch of Federal Employees' Union No. (2).[1]

Plan No. (1) received very little support. A large number of speakers discussed plans Nos. (2) and (3). It was generally agreed that organization was necessary; that the situation of the scientific and technical bureaus is serious, as the better men tend to leave and can not be replaced under the existing salary scale; and that cooperation with existing organizations is not excluded by either Plan (2) or Plan (3).

[1] Federal Employees' Union No. 1 was organized in San Francisco No. 2 embraces practically all governmental bureaus in the District of Columbia

Some of the arguments and assertions presented were as follows:

For Plan (2) and against Plan (3): A general employees' union does not and can not represent the special problems of the scientific group. The scientist does not work by hours. The scientist is much more easily appealed to by proper conditions and by recognition than by financial considerations. The scientist works best under conditions similar to those of the university teacher. Independence of action would be too greatly limited by affiliation with the Union. Many things are done in the name of organized labor which are not approved by the great majority of scientists. A political threat through affiliation with the American Federation of Labor is an undesirable method. The government employee owes full allegiance to the government and should join no organization which might conceivably interfere with that allegiance. Affiliation will keep out many who would join an independent organization. If found desirable, affiliation with the union may be brought about later.

For Plan (3) and against Plan (2): An independent organization would not be large enough to exert any influence. Affiliation will help to bring the needs of the scientific profession before the public. There is an unfounded belief in the public mind that the scientific investigator is not a producer; independent organization would only tend to confirm such a prejudice. The American Federation of Labor has no control over the action of its constituent unions. All organizations take actions that are not approved by considerable fractions of their membership. The plan does not involve a political threat. Congress, in general, desires information and wishes to act justly toward the federal employees and has welcomed the aid of the Union. The constitution of the Union forbids strikes, either direct or sympathetic. Over 550 scientific and technical workers are already a part of the Union's 21,000 members. The Union has in three years secured the following benefits to all federal employees: A general increase of salary; the defeat of the Borland amendment to increase the hours; progress on a retirement plan; and the Reclassification Commission. The Joint Congressional Reclassification Commission, which wishes to deal with employees through organizations and not as individuals, is now at work and immediate action is necessary; Union funds and machinery are available for immediate action.

The meeting voted 185 to 132 in favor of Plan No. (3). R. H. True was elected chairman, and P. G. Agnew, of the Bureau of Standards, secretary, of the temporary organization, consisting of a general interim committee composed of the chairman and secretary and representatives from the scientific and technical bureaus, one representative for each 20 members.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 9 JUNE 4, 1919 No. 11

PHYSICAL CHEMISTRY.—*The statement of acidity and alkalinity, with special reference to soils.* EDGAR T. WHERRY, Washington, D. C.

In the course of observations on the acid and alkaline reactions of soils supporting the growth of native plants, which the writer has been making at odd times during the past several years, considerable attention has been paid to the method of presenting the results; and it has been concluded that the usual plans can be improved upon, especially from the point of view of their ease of comprehension on the part of workers in non-mathematical sciences. Certain suggestions in this connection are put forward in the present note.

Two different methods of stating reactions are in general use by chemists, the "concentration" and the "potential" methods. In the concentration method the number of gram equivalents of hydrogen-ion per liter is stated, usually as an integral power of 10 with a coefficient; in the potential method, the exponent of 10, stated to one decimal place (which is directly proportional to the electric potential produced by the hydrogen-ion) is used alone. Thus, the acidity of a given solution might be described as either 5.0×10^{-6} gram-equivalents of H^+ per liter, or as $P_H = 5.3$. It takes, however, considerable effort to appreciate the relative magnitude of quantities thus stated; to tell off-hand, for instance, whether 5×10^{-6} is greater or less than 6×10^{-5}; to realize that a solution with $P_H = 2.4$ is 6300 times as acid as one with $P_H = 5.6$; and to recognize whether a given solution is acid or alkaline in reaction without considering the relation of the exponent to 7 (that of a neutral solution).

The usefulness of methods in which computation begins at the neutral point in describing reactions has been urged by Walker and Kay for natural waters,[1] by L. J. Henderson[2] for biological fluids, and by the writer for soils.[3] The plan adopted by the first two authors has been criticized by Clark and Lubs[4] as "very inadequate," but that depends on the point of view. The methods here proposed, which represent an extension of those just referred to, are contrasted with the usual ones in table 1; they appear to the writer quite adequate to express the relations involved, and to possess several distinct advantages, as pointed out in the discussion of the table.

The first five columns of table 1 need no comment, as they represent simply a statement of well-known methods of describing reactions; but the remainder require some explanation. Under the proposed concentration method, as headings of columns 6 and 7 the terms *specific acidity* and *specific alkalinity*[5] are used, since the unit, instead of being 1 gram-equivalent per liter, as in the usual methods, is the number of gram-equivalents per liter of each ion present in a standard substance, namely pure water at ordinary temperature, which is practically 10^{-7}. The actual numbers corresponding to the powers of 10 representing the reactions likely to be met with in soils have been inserted in columns 6 and 7.

The headings of the potential columns are also new; as these values may well be called chemical potentials, the letter X, representing the Greek letter *chi*, the initial of *chemical*, is applied to them.[6] It may be noted here that only the first of these columns need be used, if in the definition of chemical potential the sign of the ion is included; that is, when a given number is

[1] Journ. Soc. Chem. Ind. 31: 1013. 1912

[2] Science 46: 73. 1917.

[3] Journ. Wash. Acad. Sci. 6: 675. 1916. 8: 591. 1918.

[4] Journ. Bacter. 2:14. 1917.

[5] WALKER and KAY called them *relative* acidities and alkalinities; the writer in previous publications has used the term intensity of acidity and alkalinity, but it is better to limit the conception of intensity to potentials. *Acidivity* and *alkalivity* might be used if desired.

[6] For the suggestion of this symbol, as well as for much additional assistance in the preparation of this paper, the writer is indebted to Dr. E. Q. ADAMS of the Bureau of Chemistry.

stated, it is understood that it is + when applied to a positive ion and — to a negative one.

In the last column are given descriptive terms for such reactions as are commonly met with in soils. In the study of soils associated with various native plants the writer has found that

TABLE 1

COMPARISON OF DIFFERENT METHODS OF STATING REACTIONS

General reaction	Usual methods: Concentration		Usual methods: Potential		Proposed methods: Concentration		Proposed methods: Potential		Proposed descriptive terms
	H^+	OH^-	P_H	P_{OH}	Specific Acidity	Specific Alkalinity	X_H	X_{OH}	
	10^{-0}	10^{-14}	0	14	10^7	10^{-7}	7	−7	
	10^{-1}	10^{-13}	1	13	10^6	10^{-6}	6	−6	
	10^{-2}	10^{-12}	2	12	10^5	10^{-5}	5	−5	
	10^{-3}	10^{-11}	3	11	10^4 (10,000)	10^{-4}	4	−4	Superacid
Acid	10^{-4}	10^{-10}	4	10	10^3 (1000)	10^{-3}	3	−3	Mediacid
	10^{-5}	10^{-9}	5	9	10^2(100)	10^{-2}	2	−2	Subacid
	10^{-6}	10^{-8}	6	8	10^1(10)	10^{-1}	1	−1	Minimacid[a]
Neutral	10^{-7}	10^{-7}	7	7	10^0(1)	10^0(1)	0	0	Minim alkaline[a]
	10^{-8}	10^{-6}	8	6	10^{-1}	10^1(10)	−1	1	Subalkaline
	10^{-9}	10^{-5}	9	5	10^{-2}	10^2(100)	−2	2	Medialkaline
Alkaline	10^{-10}	10^{-4}	10	4	10^{-3}	10^3 (1000)	−3	3	Superalkaline
	10^{-11}	10^{-3}	11	3	10^{-4}	10^4 (10,000)	−4	4	
	10^{-12}	10^{-2}	12	2	10^{-5}	10^5	−5	5	
	10^{-13}	10^{-1}	13	1	10^{-6}	10^6	−6	6	
	10^{-14}	10^{-0}	14	0	10^{-7}	10^7	−7	7	

[a] May be grouped together as "circumneutral."

certain more or less well-defined types of reaction can be recognized, and it seems desirable to have a special name to apply to each of these. Starting at the acid end of the series, and using for simplicity the numerical specific acidities and alkalinities, these are as follows:

Specific acidities greater than 1000 are shown only by bog-peat, which supports a characteristic flora of "oxylophytes" or acid-soil plants; for such reactions the term *superacid* may be used. Some bog-peats, many upland-peats, and other soils also supporting oxylophytes, show values of from 1000 down to 100; for these the term *mediacid* seems appropriate. Many ordinary woods soils and field soils are also acid, but to a degree so much smaller that typical oxylophytes do not grow in them; the specific acidities under such conditions range from 100 down to 10, and may be characterized by the well-known term *subacid*. The slight degree of acidity represented by numbers less than 10, for which *minimacid* is suggested, and the similar alkalinities up to 10, *minimalkaline*, are observed in woods and field soils, also associated with certain types of plants; there is no evidence of marked change in flora on passing the neutral point, so such reactions may in general be classed as *circumneutral*. The soils derived from limestone rocks under conditions where the lime is not extensively leached out, and also natural waters rising through calcareous materials, often show a specific alkalinity of from 10 to 100, and for them the term *subalkaline*, corresponding to that used on the acid side for a similar range, may be used. *Medialkaline* and *superalkaline* soils, using these prefixes in the same senses as was done on the acid side, are presumably met with in "alkali" regions where free sodium carbonate occurs.

It is realized that the division of reactions into groups of equal length in the above manner is a somewhat artificial and arbitrary procedure. No claim is made, however, that the dividing lines between the groups are actually important critical points, at which the growth of any large number of species ceases. This method of subdivision and nomenclature is merely put forward to fill what is believed to be a real need, namely, for a series of readily understandable and roughly quantitative terms which may be used in the description of the reactions of soils, especially in discussions of plant distribution.[7]

Certain advantages possessed by the proposed methods of stating reactions may now be indicated. The neutral point is

[7] An example of how the method works out in practice will shortly be published elsewhere.

clearly marked by the figure 0; the exponents of the H and OH ions present in a given solution differ only in sign, and solutions of equivalent acidity and alkalinity are described by numerically identical terms, which is not the case in the usual methods. But the most desirable feature appears to the writer to be the ease with which the relative magnitudes of reactions under comparison can be appreciated when the numerical specific acidities and alkalinities are used. For example, in a recent study of the occurrence of azotobacter in cranberry soils[8] it was found that untreated soils had $P_H = 5.4$ to 5.6, and limed soils 6.2 to 6.4. With this method of statement it is not apparent, without stopping to calculate it out, in what direction the reaction has been altered or how extensive the change has been. If the same data are stated by the proposed chemical potential method, however, $X_H = 1.6$ to 1.4 and 0.8 to 0.6 respectively; and when 10 is raised to these powers the corresponding numerical specific acidities are 40 to 25, and 6 to 4, showing directly and clearly that liming has reduced the acidity to about $1/6$ of its original amount.

In conclusion, it may be remarked that the proposed methods of describing reactions are by no means adapted only to work with soils; they may prove useful in other fields as well. It may be urged especially that the readiness with which the numerical specific acidities and alkalinities can be understood by workers in nonmathematical sciences should lead to favorable consideration of this method whenever results obtained by physical-chemical measurement are to be applied in other fields.

BOTANY.—*Intolerance of maize to self-fertilization.* G. N. COLLINS, Bureau of Plant Industry.

Of the important cultivated crop plants maize is perhaps the least tolerant of self-fertilization. Only one strain among hundreds that have been tested has yet been discovered, the vigor of which is not reduced by even a single generation of self-fertilization. Many strains that have been under investigation

[8] GAINEY, Science 48: 654. 1918.

require special care to keep them alive after four or five successive self-pollinations. In view of this serious limitation it seems remarkable that the species has developed no adequate means of avoiding self-pollination.

The staminate and pistillate flowers of maize are borne on different parts of the plant, but most varieties are synacmic, or at most slightly proterandrous, and as the staminate flowers are at the top of the plant it is only when winds continue during all the time pollen is being shed that self-pollination is avoided. It is obviously of advantage to a plant with the sexes disposed as in maize not to be entirely dependent on cross-pollination. But it appears almost equally obvious that a slight departure from synacmy toward proterogyny would be more advantageous than a similar departure in the direction of proterandry.

Maize may be successfully pollinated at any time within 5 to 10 days after the emergence of the silks. With a variety normally proterandrous, pollen continues to fall from a plant for one or two days after the silks emerge. If a period of calm prevails at this time, the ear will be fertilized by pollen from the same plant. Should there be wind during the forenoon, when most of the pollen is liberated, or if the plant be slightly more proterandrous, fertilization will be dependent on pollen from other plants, and if no foreign pollen is at hand the ear will be sterile. If, on the other hand, the silks were to appear before the pollen, there would be the same opportunity for cross-pollination as with proterandrous plants, and should no foreign pollen be available, pollen from the same plant beginning to fall while the silks were still receptive would give self-pollinated seed instead of a sterile ear.

From the behavior of varieties imported from the tropics it was at one time thought that the more primitive varieties of maize were more proterandrous, and that the practically synacmic nature of improved varieties was the result of intensive breeding.[1] As selection is usually practiced, markedly proterandrous individuals would be considered barren stalks and

[1] Collins, G. N. *A variety of maize with silks maturing before the tassels.* U. S. Dept. Agric. Bur. Pl. Ind. Circ. 107. February 7, 1913.

would be eliminated. It now appears, however, that the growing of a variety in a new environment may result in accentuating the proterandrous character. Since the investigations with primitive types have been conducted in this country with introduced material, it may be that the observed proterandrous tendency of these types is due largely to environmental causes. The idea that maize may be of hybrid origin makes possible another explanation of why maize is synacmic and at the same time intolerant of self-pollination.

Euchlaena, the nearest relative of maize and usually regarded as an ancestor, is not intolerant of self-fertilization. Comparisons of selfed and crossed strains of Euchlaena do not show a measurable reduction of vigor as a result of self-pollination, and there is no difficulty in maintaining vigorous selfed strains. In fact, as a result of the excessive branching that obtains in Euchlaena, a very large proportion of the seed is normally self-pollinated. Intolerance of self-fertilization is therefore among the characters of maize that must be sought outside Euchlaena.

If intolerance of self-pollination were derived from some other source than Euchlaena, it seems not unreasonable to suppose that the ancestor possessing this intolerance would have also some means of securing cross-fertilization, which is not necessary in Euchlaena. This means is suggested by another non-Euchlaena character, the tendency to produce perfect flowers or androgynous inflorescences which are proterogynous.

Whenever both stamens and pistils are developed in the same maize inflorescence, the silks appear before the pollen falls. This is true for both terminal and lateral inflorescences. Terminal inflorescences mature before the lateral, and since the normal pistillate inflorescence has the lateral position, the delay attendant on this position neutralizes the natural proterogyny, with the result that maize plants generally are synacmic or proterandrous. There is thus a sense in which maize is proterogynous, the proterandry being that of the plant instead of the individual flower or inflorescence and resulting from the separation of the sexes into different parts of the plant.

Whenever two plants with widely different characteristics are crossed, characters, which in either parent may be advantageous, may unite to make an unfavorable combination. It has been assumed that the plant which combined with Euchlaena to produce maize must have been perfect-flowered. It now seems reasonable to assume also that this other ancestor was adequately protected against self-fertilization by complete proterogyny.

If a perfect-flowered proterogynous plant with a terminal inflorescence were combined with Euchlaena, the inability to withstand self-pollination might be retained, while the segregation of the sexes to different parts of the plant would result in the practical loss of the proterogyny.

In view of these considerations, it is suggested as probable that the extreme intolerance of maize to self-pollination was introduced through a perfect-flowered ancestor and that in this ancestor the danger of self-pollination was guarded against by proterogyny.

ZOOLOGY.—*Recent zoological explorations in the western Arctic.*[1] RUDOLPH MARTIN ANDERSON, Biological Division, The Geological Survey, Ottawa, Canada. (Communicated by M. W. Lyon, Jr.)

The early explorers of this region—Hearne, Ross, Franklin, Dease and Simpson, Collinson, McClure and others—were usually naval officers or agents of the Hudson's Bay Company, and made very few observations on the animal life outside of occasional comments on the larger game animals or the few species important to the fur trade. The first really important zoological work to result from these explorations was done by Dr. John Richardson, who travelled in the western Arctic in 1821–23, 1826–27, and 1847–48, summarized in the accounts of these explorations, and in the monumental "Fauna Boreali-Americana."

[1] Abridged from a paper read before the Biological Society of Washington, April 5, 1919.

The next great naturalist in the north was Roderick MacFarlane, still living in Winnipeg, who, beginning in the late fifties and continuing until the nineties, enriched the United States National Museum with collections made in the Mackenzie basin and the region around Liverpool Bay and Franklin Bay. E. W. Nelson at St. Michaels and farther north from 1877 to 1881, and John Murdoch at Point Barrow in 1881–83, made very important contributions both to collections and to zoological literature. Other scientific collectors who reached spots on the western Arctic coast were Frederick Funston (about 1896), E. A. McIlhenny (1898), and Frank Russell (1894). David T. Hanbury (1904) and Roald Amundsen (1906–07) made some notes, but little in the way of zoological collections.

Mr. E. A. Preble, of Washington, although not strictly an Arctic worker himself, in 1908 summed up all previous Arctic zoological work and bibliography in his *Biological investigations of the Athabaska-Mackenzie Region* (North American Fauna, No. 27).

The speaker, in carrying on zoological collecting and exploration for the American Museum of Natural History in the Arctic from 1908 to 1912, visited practically all points on the Arctic coast from Point Barrow, Alaska, to Coronation Gulf, as well as many Arctic districts away from the coast, notably on both sides of the Endicott Mountains divide in Alaska, the Mackenzie delta, and the edge of the timber-line in the Great Bear Lake and Coppermine River region in Canada. The Canadian Arctic Expedition, 1913–16, covered a good part of the same region, although its activities were mainly on or near the coast. The first year's base (1913–14) was at Collinson Point, Alaska, and the base for the next two years on Dolphin and Union Strait, whence the territory was worked west to Darnley Bay and east to Bathurst Inlet. The southern branch of the expedition was prepared for both terrestrial and marine zoological work, and extensive collections of plants, insects, fishes, and invertebrates were made, as well as good series of the larger animal forms. The northern division of this expedition was mainly interested in geographical work and did very little zo-

ological work. The reports of this expedition are now being published by the Canadian government in extended form, the separates on each group being distributed as soon as printed.

The principal difficulties in Arctic zoological work are (1) difficulty of transportation; (2) limited fauna in winter; (3) limited scope for field work in each summer; (4) necessity of moving at best season for field work.

It is worthy of note that the eastern North American land fauna runs far to the westward along the Mackenzie River system. Traces of Western influences begin to appear in the Mackenzie delta.

Tongues of the Hudsonian life zone extend far beyond the Arctic Circle in places. The isothermal lines are very irregular.

The prevailing east and west migration along the Arctic coast brings some Pacific forms far east along the coast.

There is an extensive north and south bird migration along part of the Mackenzie system, the Anderson River, Liverpool Bay, and towards Banks Island.

There is little migration along the Coppermine River.

Traces of the Siberian fauna come across from Bering Strait and Kotzebue Sound to the Colville delta on the Alaskan Arctic coast.

There has evidently been a great diminution of some forms of bird life in the Arctic in recent years, the same as elsewhere, but this is not primarily due to destruction by natives, except perhaps in parts of western Alaska.

The reduction of game and fur animals is due principally to white men's influence, directly or indirectly. The numbers of individuals and conditions of existence of many species are rapidly changing over many large areas in the Arctic, and causing rapid and extensive shifting of native population.

The Arctic marine life is fairly uniform in circumpolar regions, the conditions of life being nearly uniform. Large series of terrestrial animals show that there is less variation of some species over large areas, than has been supposed.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

GEOLOGY.—*Geology and mineral deposits of the Colville Indian Reservation, Washington.* J. T. PARDEE. U. S. Geol. Survey Bull. 677. Pp. 180, 12 plates and 1 figure. 1918.

The rocks exposed are the Covada group which consists of schistose argillite, greenstone, and limestone of probable Carboniferous age; the intrusive Colville granite probably Cretaceous; dike rocks and lavas of Tertiary age; and Pleistocene glacial deposits.

The Pleistocene Cordilleran Ice cap overran all the Reservation except part of San Poil Valley. After the ice had withdrawn the valley of Columbia River was ponded to the present 1700 foot contour. This water body was displaced by the Nesplem Silt from which the river carved terraces as it re-excavated its channel. The Nesplem Silt is correlated with the White Silt formation of Dawson in Frazer valley, British Columbia.

The mineral deposits consist chiefly of veins that contain silver, lead, and zinc and contact metamorphic deposits valuable mainly for copper. Most of the known lodes of economic importance are confined within four more or less definite area near Nesplem, Park City, Covada, and Keller. With respect to rock formations, the lodes are about equally divided between the Colville granite and the Covada group. No metal-bearing lodes have been found in rocks younger than the Colville granite. Most of the veins are narrow, the oxidized zone is shallow, and secondary enrichment, though conspicuous in one or two mines, is not common. Some of the contact metamorphic deposits are large but of very low grade. J. T. P.

GEOLOGY.—*Relation of landslides and glacial deposits to reservoir sites in the San Juan Mountains, Colorado.* WALLACE W. ATWOOD. U. S. Geol. Survey Bull. 685. Pp. 38, 8 plates, 17 figs. 1918.

Inasmuch as experience has shown that many landslide masses and certain of the glacial deposits are not able to withstand the pressure of a high head of water without serious leakage, it seems desirable to publish a description of the mountain canyons and the deposits commonly found in them and of the geologic conditions associated with the lakes in the mountains, so that, in the future, no expensive errors need be due to a failure to recognize the geologic formations bordering a proposed reservoir site. Glacial deposits of the Wisconsin glacial stage are described in detail. Landslides and torrential deposits in larger canyons are discussed. Several reservoirs are described and illustrated in detail. R. W. STONE.

GEOLOGY.—*Geology and ore deposits of the Tintic mining district, Utah.* WALDEMAR LINDGREN and G. F. LOUGHLIN, with a historical review by V. C. HEIKES. U. S. Geol. Survey Prof. Paper No. 107. Pp. 282. 39 plates, 49 figures. 1919.

The report gives the result of a detailed re-survey of the Tintic district, results of the first survey by G. W. Tower, Jr., and G. O. Smith having appeared in the nineteenth annual report of the Survey in 1898. The scope of the report is similar to that of other Survey professional papers on mining districts, and particular attention may be directed to the following features:

Part I (by G. F. L.):—Revision of the stratigraphy based on newly-discovered paleontologic evidence, proving the existence of lower, middle, and upper (?) Cambrian, lower and upper Ordovician, upper (?) Devonian, and Mississippian strata; unconformities at the base of the Ordovician and of the Mississippian; description and correlation of igneous rocks, including early latite or andesite, early and late rhyolites, later latites and monzonite, and basalt; magmatic differentiation of the igneous rocks, comparing evidence for and against magmatic stoping, abyssal and marginal assimilation; folding and faulting, the latter taking place during 5 periods; rock alteration considered under three heads: (*a*) before volcanic activity (formation of chert, dolomite, and some sericite, and prevolcanic products of weathering); (*b*) during and immediately after volcanic activity; (*c*) distinctly later than volcanic activity.

Part II (by V. C. H.):—Gives history and production from 1869 to 1916, including production by ore zones and by kinds of ore; also the history of smelting and milling.

Part III (by W. L.):—Discusses relations of deposits to fractures in igneous and sedimentary rocks, showing selective replacement of limestone; underground water; mineralization, with particular attention to silicification of limestone and dolomite, paragenesis of ore and gangue minerals, horizontal and vertical zones of deposition, and processes of oxidation of different ores, genesis of the ore deposits; future of the district. Detailed descriptions of mines follow, and reconnaissance reports on the East Tintic and North Tintic districts are included.

G. F. L.

GEOLOGY.—*The Genesis of the ores at Tonopah, Nevada.* U. S. Geol. Survey Prof. Paper 104. EDSON S. BASTIN and FRANCIS B. LANEY. Pp. 47, 16 plates, 22 figs. 1918.

This investigation supplements the work of Spurr and Burgess by applying to the ores methods of microscopic study not in general use when these reports were prepared. The Tonopah district is underlain by a thick series of rocks that are products of volcanic activity and are believed to be of Tertiary age. In spite of complicated faulting most of the volcanic formations are rather flat-lying. In 1915 the Tonopah production of silver was exceeded in the United States only by that of Butte.

The bulk of the metal production of the district has come from ore bodies lying wholly within the Mizpah trachyte. Following are the more important conclusions:

1. The hypogene or primary ores have been modified in places by oxidation and enrichment through the agency of the air and oxygenated solutions originating at or near the surface. The high silver content of much of the ore obtained in the past and of some ore now remaining is unquestionably due in part to these processes.

2. There is evidence not only of recent oxidation of the ores but also of at least one period of ancient oxidation, and supergene sulphide enrichment was probably an accompaniment of each of these periods.

3. The rich silver ores now being mined at Tonopah are probably in the main of hypogene or primary origin.

4. Mining has shown that in certain veins the primary sulphides become less abundant with increasing depth, though the same species are present; mere increase in depth may account for this change in

some veins, for every vein must finally end in depth as well as laterally; in many veins change in wall rock has been at least a contributing factor. The veins developed by other deep workings are heavily mineralized and of high grade, and the geologic evidence is favorable to the persistence of rich primary silver ores to depths considerably greater than those yet attained in the mining operations.

Although hot ascending waters are encountered in a number of the deeper workings, there is little evidence that these waters are now depositing ores. R. W. STONE.

GEOLOGY.—*Coal south of Mancos, Montezuma County, Colorado.* A. J. COLLIER. U. S. Geol. Survey Bull. 691-K. 16 plates, 2 figs. 1919.

There are two coal-bearing formations near Mancos, Colorado, the Dakota sandstone, in the lowlands north of the town, which yields a very impure coal of bituminous rank, and the middle formation of the Mesaverde group which yields a coal of somewhat lower rank than the Dakota coal, though relatively pure and much esteemed as a fuel.

The formations have a uniformly low dip to the south. The coal beds here described are all in the Menefee formation, are bituminous and are nearly all less than 6 feet thick. Three mines supply local demand.

R. W. STONE.

GEOLOGY.—*Geology of the Lost Creek coal field, Morgan County, Utah.* FRANK R. CLARK. U. S. Geol. Survey Bull. 691-L. Pp. 311–322, 1 plate, 1 fig. 1918.

The Lost Creek coal field lies in Morgan County, Utah, about 10 or 12 miles northeast of Devil's Slide Station, on the main line of the Union Pacific Railroad.

The coal bed, which is lenticular and varies greatly in thickness even in small areas, is confined to one coal-bearing zone. It is sub-bituminous and contains much moisture and many impurities in the form of small lenses or partings of bone and shale.

The rocks exposed in this field comprise two formations which differ widely in character as well as in age; the older formation is of Jurassic age and the younger of Tertiary age (Wasatch formation). These formations are separated by a great unconformity representing a long interval of time during which the older rocks were minutely folded and the folds were later truncated by erosion. The rocks that are here assigned to the Jurassic consist of limestone, shale, and well-indurated sandstone.

The rocks overlying the Jurassic unconformably are correlated with the Wasatch formation of Echo Canyon, and consist of an upper and a lower conglomerate and intervening sandstone and shale.

The structure of the Jurassic formation is intricate and complicated. The rocks are highly folded and may be faulted.

The Wasatch beds were laid down on the truncated edges of the Jurassic rocks and are now generally flat lying.

The coal in the Lost Creek field occurs in small areas and is generally too thin to be of economic value.

The Lost Creek coal, being inferior in rank to subbituminous coal of nearby fields, is not likely to receive serious attention.

R. W. Stone.

GEOLOGY.—*A geologic reconnaissance for phosphate and coal in southeastern Idaho and western Wyoming.* Alfred Reginald Schultz. U. S. Geol. Survey Bull. **680**. Pp. 81, 2 plates, 8 figures. 1918.

Describes fully the stratigraphy of the region, embracing a geologic column from pre-Cambrian to Quaternary; describes the geologic structure briefly. The occurrence of phosphate rock in several localities is given in such detail as is possible from reconnaissance examination only, but it is apparent that in the Snake River Range, Bighole Mountains, and Teton Range, particularly along the east side of Teton Basin, a large amount of phosphate is present. The analyses show considerable variation but they indicate the presence of some high-grade ore that contains approximately the equivalent of 70 per cent of tricalcium phosphate. Beds of coal have been found at several localities in this field and are at present being mined in a few places. Most of the coal beds that have been exploited are of Cretaceous age, belong to the Frontier formation, and represent the northward extension of the coal beds which are so extensively developed and on which active mines are located in southern Lincoln County, Wyoming. Beds of coal are also found in rocks stratigraphically below the Frontier formation, which probably represent the Bear River coals that have been prospected in the vicinity of Sage, Wyoming, but on which no active mines are located. The coal is bituminous and rather free from impurities, and occurs in beds 1 to 4 feet thick. According to report some of it has been coked with fair success. Most of the coal is badly shattered, as would be expected in a region where so much faulting has taken place. Several sections and analyses are given. R. W. Stone.

GEOLOGY.—*The Upper Chitina Valley, Alaska.* FRED H. MOFFIT. U. S. Geol. Survey Bull. 675. Pp. 80, 13 plates, 2 figs. 1918.

This report deals largely with the more purely scientific aspects of the geologic problems, discussing at considerable length the stratigraphy and the igneous rocks. It has been proved that the copper-bearing rocks, which have yielded valuable deposits in the lower Chitina Valley, occur also in the upper valley. It is also shown that the formations from which the Nizina placers have derived their gold occur in this region. On the other hand, no mineral deposits of proved value have yet been exploited in the upper Chitina basin. It must be said, however, that comparatively little prospecting has been done in this field.

R. W. STONE.

GEOLOGY.—*The Nelchina-Susitna Region, Alaska.* THEODORE CHAPIN. U. S. Geol. Survey Bull. 668. Pp. 64, 10 plates, 4 figs. 1918.

Discusses the distribution, age, and correlation of the various geologic formations in a little-known region, and the development of its land forms. There has been but little productive mining in the region, and its geology does not encourage the hope of finding extensive placers, yet the wide distribution of alluvial gold indicates considerable mineralization. Moreover, the presence of a large number of intrusive igneous rocks also encourages the hope of finding local mineralization of the bedrocks.

R. W. STONE.

GEOLOGY.—*The Nenana coal field, Alaska.* G. C. MARTIN. U. S. Survey Bull. 664. Pp. 54, 12 plates. 1919.

The Nenana coal field lies southwest of Fairbanks in the northern foothills of the Alaska Range. The rocks of the Nenana coal field consist of the coal-bearing beds, metamorphic and igneous rocks beneath the coal-bearing beds, and gravel, sands, and silts above them.

The coal-bearing strata consist of slightly consolidated sands, clays, and gravels with numerous beds of lignite. These beds are of Tertiary age. The coal-bearing beds rest unconformably upon Paleozoic (?) schist and igneous rocks and are overlain unconformably by Quarternary gravels, 1,500 or 2,000 feet thick.

The structure of the coal areas is fairly simple. The individual coal areas consist of shallow and gently warped basins in which the beds are at some places steeply folded or faulted against masses of crystalline

rock that separate the basins. No intrusive rocks are known to cut the coal measures.

The coal of the Nenana field occurs in many beds of different thickness, the thickest measuring perhaps 30 to 35 feet, which are distributed rather uniformly through the coal measures. At least twelve coal beds are of workable thickness, and six or more measure over 20 feet. The analyses show that the coal is a lignite of good grade, of about the same quality as that of Cook Inlet. R. W. STONE.

ORNITHOLOGY.—*Description of a new subspecies of the little yellow bittern from the Philippine Islands.* ALEXANDER WETMORE. Proc. Biol. Soc. Wash. 31: 83–84. June 29, 1918.

The form of *Ixobrychus sinensis* occurring on the Philippine Islands proves to be different from all the other races of this species, and, as it has no distinctive name, is to be known as *Ixobrychus sinensis astrologus* Wetmore. It is apparently most closely allied to *Ixobrychus sinensis bryani* (Seale), from the island of Guam in the Marianne group, from which it differs chiefly in its smaller size, darker upper parts, and paler neck. Its type is from Paete, Laguna, Luzon Island, Philippine Islands, and its range extends from the island of Luzon to Panay Island in the Philippine Archipelago. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*The migration of North American birds. VI. Horned larks.* HARRY C. OBERHOLSER. Bird Lore 20: 345–349 (map). 1918.

The geographic distribution of the American horned larks extends from the Arctic Ocean to Bogotá, Colombia. Twenty-three subspecies are now distinguishable, most of which are resident. Five subspecies not currently recognized are here revived and their geographic distribution delineated. These forms are *Otocoris alpestris enthymia*, *Otocoris alpestris aphrasta*, *Otocoris alpestris leucansiptila*, *Octocoris alpestris*, *ammophila*, and *Otocoris alpestris enertera*. The map shows the distribution of all the American forms, and tables indicate the migration movements of the four forms that are most migratory.
H. C. O.

ORNITHOLOGY.—*Birds of Glacier National Park.* FLORENCE MERRIAM BAILEY. General information regarding Glacier National Park, season of 1918. 52–64. 1918.

This list of 184 species and subspecies is reasonably complete for

the Glacier National Park. It comprises all the species heretofore authentically reported from the Park, together with many unpublished data from recent field work in this region. It may be regarded as a preliminary contribution, and contains only brief notes on each species and subspecies, including their manner and place of occurrence in the Park. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Bones of birds collected by Theodoor de Booy, from kitchen-midden deposits in the islands of St. Thomas and St. Croix.* ALEXANDER WETMORE. Proc. U. S. Nat. Mus. **54**: 513–522, pl. 82. 1918.

A collection of seventy-three fragments of bird bones from kitchen-midden deposits on the islands of St. Thomas and St. Croix furnishes a number of interesting records. Among these remains thirteen species are represented, including three not identifiable more than generically. Nine species are attributed to the island of St. Thomas, including five not hitherto recorded. These five are *Puffinus lherminieri*, *Sula leucogastris*, *Fregata magnificens* [*rothschildi*], *Anous stolidus*, and an interesting new genus and species of the family *Rallidae*. The last mentioned is apparently most closely allied to the genera *Aramides* and *Galliral1us*, and is here named *Nesotrochis debooyi*. From St. Croix six species are recorded, of which *Sula piscator* [= *Sula sula*], *Nesotrochis debooyi*, and *Corvus leucognaphalus* were previously unknown from this island. The last is of particular interest, since no species of this genus has been recorded in the West Indies farther east than the island of Porto Rico. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Attracting birds to public and semipublic reservations.* W. L. MCATEE. U. S. Dept. Agric. Bull. 715: 1–13. 1918.

Birds exert a steady influence in reducing the numbers of injurious insects and other plant feeders, and should, for this reason, be particularly useful in public reservations. Birds are beneficial as enemies of a great variety of pests, and many observers claim that an abundance of birds on their grounds has kept down all the ordinary enemies of vegetation. They are, therefore, deserving of careful protection; and more attention should be given to attracting them to public and semipublic reservations such as national parks, national forests, national bird reservations, state parks, zoological gardens, the environs of res-

ervoirs and water works, boulevards, and roadsides. On the national reservations much could be done to attract waterfowl by planting suitable water plants which form a large part of the food of such birds, and by furnishing for upland game birds coverts which would also provide abundant food from their fruits. In public parks and zoological gardens the bird population may be very much increased by the proper installment of drinking places, bird boxes for breeding places, and feeding stations during the winter; nor should the planting of suitable trees and shrubs on parkways, boulevards, and along roadsides be neglected. Without much doubt the use of bird-attraction methods on such public and semipublic lands would benefit not only these areas but, through the increased destruction of injurious insects, also all the adjoining lands and the country at large.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*The duck sickness in Utah.* ALEXANDER WETMORE. U. S. Dept. Agric. Bull. 672: 1–26. 1918.

The annual losses from disease among wild fowl in the Salt Lake Valley, Utah, became so great that the Biological Survey began, in 1913, an investigation of the causes. Although for many years the ducks in the Bear River marshes, at the northern end of Great Salt Lake, have been known to be affected by a peculiar sickness, this did not become serious until 1910; but in that year so many thousand wild ducks died in this region that sportsmen and other persons interested in wild fowl became much alarmed over the situation. The same condition has been reported from other areas—Owens Lake, California, Tulare Lake, California, Lake Malheur, Oregon, Lake Bowdoin, Montana, and the Cheyenne bottoms near Great Bend, Kansas. The species affected in these various outbreaks comprise 36, and include many species of ducks, gulls, terns, shore birds, and other water-fowl, together with a few land birds such as *Pica pica hudsonia*, *Xanthocephalus xanthocephalus*, *Anthus spinoletta rubescens*, and even *Petrochelidon lunifrons lunifrons*.

The most conspicuous symptoms of this peculiar duck disease indicate a paralysis of the nerve centers controlling the muscular system. It is first noted in the inability of the bird to fly for any great distance, and finally in the lack of power to fly at all. The paralysis extends later to the legs and feet, then to the head and neck, so that the bird ultimately becomes entirely helpless.

Many theories were advanced regarding the cause of this peculiar malady. One of these attributed it to a bacterial or protozoan infection. Some persons claimed that the birds were poisoned by sulphurous or sulphuric acid from the smelters near Salt Lake City; and still other people contended that the sickness was due to the waste waters from the settling ponds of the sugar factories. A number of additional but much less plausible theories were also suggested. The investigations finally carried on about Great Salt Lake have clearly proved that the real cause is a toxic action of certain soluble salts found in alkali, such as the chlorides of calcium and magnesium. The birds take these into the system by feeding in water heavily charged with them, in places such as drying flats about the margin of Great Salt Lake, particularly in the Bear River region. Fresh water is the only cure, and this has been found effective in all cases of the sickness where the birds treated were not too far gone. Birds slightly affected and even many that were entirely helpless recovered nearly always when simply given moderately fresh water to drink. Since the cause of this disease over wide areas in the northern part of Great Salt Lake is the restriction of the inflow of fresh water, the chief possible means of alleviation must be found in the draining of the mud flats and the increase, somehow, of the inflow of fresh water.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Notes on North American birds. VI.* HARRY C. OBERHOLSER. Auk 35: 463–467. 1918.

Examination of a series of specimens of the belted kingfisher shows that *Streptoceryle alcyon caurina* is a readily recognizable race by reason of its greater size alone. Although the American barn owl has been recently made a subspecies of the South American *Tyto perlata*, the comparison of a series of specimens with examples of the European races indicates that the North American bird is only subspecifically related to them, and that it must therefore stand as *Tyto alba pratincola*. All the American forms of *Certhia* are certainly but subspecies, and are undoubtedly forms of the European *Certhia familiaris*, not of *Certhia brachydactyla* Brehm, as claimed by a recent author. In a recent revision of the Paridae by Dr. C. E. Hellmayr, *Penthestes carolinensis* was made a subspecies of *Penthestes atricapillus*, but a close study of these birds in life and in the cabinet indicates that they are entirely distinct species. The race of Myrtle warbler described as

Dendroica coronata hooveri by Mr. R. C. McGregor has not been currently recognized, but a thorough study of a large amount of material proves that it is readily separable by both size and color. The redpoll known as *Acanthis hornemanni exilipes* Coues has recently been claimed to be a subspecies of *Acanthis linaria*, but since the two breed in the same localities over wide areas they must be specifically distinct.

H. C. O.

ORNITHOLOGY.—*Mutanda ornithologica. IV.* Harry C. Oberholser. Proc. Biol. Soc. Wash. 31: 125–126. November 29, 1918.

By the change of the generic name *Euphonia* to *Tanagra* the current names of several species and subspecies become untenable. By this transfer to the genus *Tanagra*, the *Euphonia vittata* of Sclater becomes preoccupied and is here named *Tanagra catasticta*. For a similar reason *Euphonia aurea pileata* Berlepsch is renamed *Tanagra aurea cynophora; Euphonia violacea magna* Berlepsch must be known under the new name, *Tanagra violacea pampolla* Oberholser; *Euphonia laniirostris peruviana* Berlepsch and Stolzmann must be called *Tanagra laniirostris zopholega* Oberholser; and *Euphonia olivacea* Desmarest must be replaced by *Tanagra minuta* (Cabanis). H. C. O.

ORNITHOLOGY.—*The migration of North American birds. II. The scarlet and Louisiana tanagers.* Harry C. Oberholser. Bird Lore 20: 16–19. 1918.

This paper contains tables of migration data for both spring and fall, together with the summer and winter distribution of *Piranga erythromelas* and *Piranga ludoviciana*. These data are from localities in the United States and Canada, and, as in the previous paper, cover the earliest, latest, and average dates of arrival and departure in both spring and autumn. H. C. O.

ORNITHOLOGY.—*Washington region [October to November, 1917].* Harry C. Oberholser. Bird Lore 20: 22. 1918.

During October and November, 1917, notwithstanding the unusually cold weather, few northern birds made their appearance. Strangely enough some birds remained later than is common, and one species, *Pisobia minutilla*, broke all its records, remaining until November 22, nearly a month beyond its previous latest date. On the other hand,

Larus argentatus appeared on November 21, which is four days ahead of its previous earliest record. Some species were more than ordinarily numerous, among which might be mentioned *Sturnella magna magna* and *Oxyechus vociferus*.

ORNITHOLOGY.—*Annotated catalogue of a collection of birds made by Mr. Copley Amory, Jr., in northeastern Siberia.* J. H. RILEY. Proc. U. S. Nat. Mus. 54: 607–626. 1918.

Mr. Copley Amory, Jr., who accompanied the Koren Expedition to the Kolyma River of northeastern Sibera in 1914, made a collection of 228 birds. These were obtained at localities ranging from near the mouth of the Kolyma River to the Tomus Chaja Mountains, and are referable to 76 species and subspecies. This paper is an annotated catalogue of these, and includes the localities and dates where each species was observed or collected, together with remarks on plumage and the status of races, and Mr. Amory's field notes on habits and distribution. Some of the interesting results of the study of this collection are the substantiation of Mr. G. M. Mathews' division of *Canutus canutus* into three subspecies; of the recently described *Budytes flavus plexus* Thayer & Bangs; and of *Otocoris alpestris euroa* Thayer & Bangs. It is also worthy of note that the Lapland longspur occurring in the Kolyma district is much nearer *Calcarius lapponicus alascensis* than to *Calcarius lapponicus coloratus*. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Description of a new subspecies of* Cyanolaemus clemenciae. HARRY C. OBERHOLSER. Condor 20: 181–182. September, 1918.

Examination of a series of *Cyanolaemus clemenciae* discloses the existence of a hitherto unrecognized subspecies, which will stand as *Cyanolaemus clemenciae bessophilus*. It differs from *Cyanolaemus clemenciae clemenciae* in its shorter bill, duller upper parts, and paler lower surface. It ranges from southeastern Arizona, southwestern New Mexico, central western Texas, south to the State of Chihuahua, Mexico, and in winter to Vera Cruz. H. C. O.

ORNITHOLOGY.—*Description of a new Lanius from Lower California.* HARRY C. OBERHOLSER. Condor 20: 209–210. November, 1918.

The breeding shrike from the southern two-thirds of Lower California, including the adjacent islands, proves to be subspecifically dis-

tinct from all the other races of the species. It is here named *Lanius ludovicianus nelsoni* in honor of Mr. E. W. Nelson, the Chief of the Biological Survey. H. C. O.

ORNITHOLOGY.—*The summer birds of the St. Matthew Island Bird Reservation.* G. DALLAS HANNA. Auk 34: 403–410. October, 1917.

The St. Matthew Island Bird Reservation consists of three islands—St. Matthew, Hall, and Pinnacle. St. Matthew Island, which is the largest of these, is some 22 miles long by two to three miles wide, and rises to an altitude of 1800 feet. The weather-worn rocks are either devoid of vegetation or covered with a scant growth of mosses and other low plants. The information presented here was gathered on a trip of investigation for the Biological Survey in July, 1916. Altogether 37 species and subspecies are now known from these islands including four reported only by Dr. A. K. Fisher in 1899. Of all these only eight are land birds. Brief notes on the abundance and manner of occurrence are added under each species. The beautiful McKay snowflake, which is confined to these islands in the breeding season, is, it is satisfactory to note, still here the most abundant land bird of the level areas. HARRY C. OBERHOLSER.

ENTOMOLOGY.—*A revision of the North American Gracilariidae from the standpoint of venation.* CHAS. R. ELY. Proc. Ent. Soc. Wash. 19: 29–77, pls. 6–9. 1918 (issued Sept. 1919).

This paper presents a new arrangement for the North American Microlepidoptera of the family Gracilariidae. It contains a generic synopsis in which great stress is laid on the venation, especially the position of vein 11 in the forewings. Three new genera are characterized and the other genera known to occur in our fauna are briefly described. A catalog of the species and a list of the food plants of the larvae adds to the usefulness of the paper. S. A. ROHWER.

ENTOMOLOGY.—*Idiogastra, a new suborder of Hymenoptera with notes on the immature stages of Oryssus.* S. A. ROHWER and R. A. CUSHMAN. Proc. Ent. Soc. Wash. 19: 89–98, pls. 11 and 12. 1918 (issued Sept. 1919).

The oryssoid Hymenoptera have long been recognized as a well-defined group but with characters which indicated that they are in-

termediate between the generalized and specialized forms. The unusual larva and larval habits, together with adult characters, caused the authors to remove the oryssoids from the suborder Chalastogastra and place them in a new suborder. The paper includes detailed descriptions of the larva and pupa of *Oryssus occidentalis* Cresson and gives diagnostic characters for the new suborder. One unusual feature of the group is the long-exserted ovipositor of the pupa which in the adult becomes concealed within the body, extending anteriorly in an inverted position into the prothorax where it rights itself and follows nearly the same course back to the apex of the abdomen where it is hidden within the sheath. S. A. R.

ENTOMOLOGY.—*A contribution to the biology of North American Diptera.* CHAS. T. GREENE. Proc. Ent. Soc. Wash. **19**: 146–157, pls. 17–20. 1918 (issued Sept. 1919).

This paper contains detailed descriptions of the larvae and pupae of six species of flies, which are rather common in the District of Columbia, and includes notes on the habits of the immature stages. Good illustrations by the author accompany the article. S. A. ROHWER.

PALEONTOLOGY.—*Pliocene Foraminifera of the Coastal Plain of the United States.* JOSEPH AUGUSTINE CUSHMAN. U. S. Geol. Survey Bull. **676**. Pp. 98, 31 plates. 1918.

Two Pliocene formations are represented: The Waccamaw formation and the Caloosahatchee marl. Nearly all the species in all the material are identical with those found at the present time along our Atlantic coast, but those from the Waccamaw formation of North and South Carolina and also some of those from Shell Creek, Florida, are much more similar to the material now found north of Cape Hatteras, while the Caloosahatchee River material represents a typically tropical shoal-water fauna such as may be found about southern Florida and in shallow water about the West Indies.

The species of Foraminifera found in the later Miocene of the Coastal Plain of the eastern United States are described or recorded. An attempt has been made to include all records of the Foraminifera reported from the Atlantic and Gulf Coastal Plain from Alabama to New Jersey. The Miocene Foraminifera are not susceptible of so definite a division into faunas as the Pliocene Foraminifera. The species of the Maryland

and Virginia region are either identical with or allied to species now occurring in comparatively shallow water in the same general region.

R. W. STONE.

MYCOLOGY.—*Rhizoctonia in lawns and pastures.* C. V. PIPER and H. S. COE. Phytopathology 9: 89–92. February, 1919.

Brown patches in fine turf have long been known, and, as they commonly occur in midsummer, have usually been ascribed to "sun scald." Observation of the spots as they occurred in 1914 near Philadelphia furnished strong evidence that the cause was an organism, but the pathologists who studied specimens failed to disclose the causal agent. The abundant occurrence of the trouble in the vicinity of Washington in 1916 and since gave opportunity for study. The brown spots usually appear in summer with the advent of hot moist weather and are most conveniently studied on well-kept turf. The spots are at first small, but increase rapidly in a concentric fashion, reaching a definite size varying from a few inches to 2 or 3 feet in diameter, and then cease spreading. In the early morning a fine white mycelium may be observed over the discolored turf. Cultures from this as well as from sclerotia on the stems proved the fungus to be the well-known *Rhizoctonia solani.* From artificial culture it was easy to induce the formation of brown patches in grass turf under favorable weather conditions.

The fungus is known to attack an enormous list of herbaceous plants, but strangely enough has never been reported as attacking any grass, although there is one record of the occurrence of the mature form of the fungus (*Corticum vagum*) on maize.

Rhizoctonia is, however, very common in lawns and pastures and has been observed by the authors in many places from Minnesota to Maine and southward to the Ohio and Potomac Rivers. Among the plants attacked are redtop, red fescue, Rhode Island bent, carpet bent, velvet bent, Kentucky bluegrass, rough-stalked meadow grass, as well as many lawn weeds. Crab-grass and Bermuda grass seem perfectly immune, as is also white clover.

Most of the grasses slowly recover in the brown patches with the advent of cool weather in fall, but some are completely killed. Certain strains of carpet bent and velvet bent grown in pure cultures near Washington are especially injured by the disease but others are completely immune. Spraying at intervals with Bordeaux mixture helps protect the grass turf, but such applications need to be frequent.

C. V. P.

Dr. H. FOSTER BAIN resigned from the Bureau of Mines in May, and will sail from Vancouver on June 12 to continue his explorations in China for New York mining interests.

Professor JOSEPH BARRELL, professor of structural geology at Yale University, and a nonresident member of the ACADEMY, died on May 4, 1919, in his fiftieth year. Professor Barrell was born at New Providence, New Jersey, December 15, 1869. His early work was in mining engineering and in the geological department of Lehigh University, following which he entered the geological faculty of Yale in 1903. Taking up geology from the view-point of the engineer, he made many contributions to the science in the fields of structural geology, metamorphism, petrology of the igneous and metamorphic rocks, and sedimentation and peneplanation in their relation to the larger problems of the movements of the earth's crust.

Lieut. Col. ALFRED H. BROOKS, geologist in charge of Alaskan Mineral Resources, U. S. Geological Survey, who has been with the American Army in France since the summer of 1917, returned to Washington on April 28. He has received his discharge from the Army and is again taking up his geological work with the Survey.

Dr. J. WALTER FEWKES, chief of the Bureau of American Ethnology, returned in April from a visit to Texas, where he inaugurated explorations of aboriginal workshops and village sites near Austin, Round Rock, and Gatesville. The work is being continued by Prof. J. E. PEARCE of the University of Texas.

Mr. JAMES M. HILL, JR., is on leave of absence from the Geological Survey. He sailed from New Orleans early in April and is a member of a party engaged in prospecting for platinum in Colombia.

Dr. WALTER HOUGH left Washington in May for Arizona, to conduct ethnological and archeological explorations in the White Mountain Apache Reservation for the Bureau of American Ethnology.

Mr. CHARLES M. HOY, of the National Museum, left Washington on April 28 for Australia, to collect animals and other biological material for the Museum.

Mr. NEIL M. JUDD left Washington on May 14 for Utah, to make an archeologic reconnaissance of the Paria plateau, near the Grand Canyon of the Colorado.

Dr. J. C. MARTIN, assistant curator in the division of economic geology of the National Museum, resigned in May to accept a position with the Geological Survey.

Mr. EARL V. SHANNON has been appointed Assistant Curator in the Department of Geology of the National Museum.

Capt. D. L. WILLIAMS, formerly of the Chemical Warfare Service, and stationed at the American University Experiment Station, is now in Utica, New York.

Major O. B. ZIMMERMAN, formerly liaison officer between the Army Engineer Corps and the Bureau of Standards, is now with the International Harvester Company in Chicago.

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Prof. J. C. Merriam will be acting chairman of the Council until July 1, 1919. Major A. O. Leuschner is acting chairman of the Division of Physical Sciences until July 1, during the absence of Dr. C. E. Mendenhall as Scientific Attaché to the American Embassy in London. Mr. G. H. Clevenger is acting chairman of the Division of Engineering during the absence of Dr. H. M. Howe as Scientific Attaché to the American Embassy in Paris. Prof. E. W. Washburn is acting chairman of the Division of Chemistry and Chemical Technology until July 1, during the period of Col. W. D. Bancroft's service with the Army. No chairman has been elected for the Division of Geology and Geography. The organization of the Division of Medical Sciences and the Division of Anthropology and Psychology has not yet been completed.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 9 JUNE 19, 1919 No. 12

ANTHROPOLOGY.—*Two proto-Algonquian phonetic shifts.* TRUMAN MICHELSON, Bureau of American Ethnology.[1]

The following paper will eventually appear in elaborated form in the *International Journal of American Linguistics*, so that this presentation is to be regarded as an abstract. Hence it is that the proofs are given concisely, and certain unimportant details are passed over.

Some years ago[2] I pointed out that in Fox the interchange of *-aw-* and *-ō-* was of regular occurrence. At the time it escaped me that *-aw-* and *-ā-* also interchanged; and that whether *-ō-* or *-ā-* interchanged with *-aw-* was dependent on the particular consonants that immediately followed. Examples are: *aʻwapiwītA'mawā*$^{\text{d}}$*tc*$^{\text{iʻ}}$ "then he began telling them," *kewītAmōn*$^{\text{eʻ}}$ "I tell thee," *nīʻwītAmāg*$^{\text{kwA·}}$ "he will tell me," *nemeʻtciwītAmā'gunān*$^{\text{aʻ}}$ "he told us (excl.) plainly;" *peʻse'tawin*$^{\text{uʻ}}$ "listen thou to me," *kīʻpe'ʻsetōn*$^{\text{e}}$ "I shall listen to thee," *nīʻpeʻsetāg*$^{\text{kwA·}}$ "he will listen to me;" *aʻtōta'wiyAn*$^{\text{iʻ}}$ "the way you (sing.) treated me," *aʻtō'tōnān*$^{\text{iʻ}}$ "the way I treated you (sing.)," *aʻtō'tāgu*$^{\text{d}}$*tc*$^{\text{iʻ}}$ "the way he was treated by;" *aʻpōnine'ʻkawā*$^{\text{d}}$*tc*$^{\text{iʻ}}$ "then he ceased pursuing them," *kīʻpemi'neʻkōn*$^{\text{eʻ}}$ "I shall pursue thee," *pemine'ʻkāʻsō*$^{\text{wA}}$ "he was pursued," Aʻcāʻ*Ani pemi'neʻkāg*$^{\text{kwAʻ}}$ "he was pursued by the Sioux;" *keneʻckina'wipen*$^{\text{aʻ}}$ "you hate us," *keneʻckinō'n*$^{\text{eʻ}}$ "I hate thee," *keneʻckināgō'g*$^{\text{iʻ}}$ "they hate thee;" *kīʻpyatawip*$^{\text{wAʻ}}$ "you will bring it to me," *kepyatōnep*$^{\text{wAʻ}}$ "I bring it to you," *aʻpyatō*$^{\text{d}}$*tc*$^{\text{iʻ}}$ "when he brings it," *pyatōt*$^{\text{eʻ}}$ "if he brings it," *kīʻpyatāgōg*$^{\text{iʻ}}$ "they will bring it to thee;"

[1] Printed with permission of the Secretary of the Smithsonian Institution.

[2] This JOURNAL 4: 403, 404. 1914.

keneno'tawi "dost thou understand me," *awita neno'tō'nAgu's^a* "he might not understand us (incl.)," *keneno'tōn^ne* "I understand thee," *keneno'tāg^kw* "he understands thee;" *keneno'tātīpen^n* "we (incl.) understand each other;" *ā'mānō''kawu^dtc* "then many attacked him" [really an independent passive in formation], *ā'mānō''kāgu^dtc^i* "then he was attacked by many;" *keteminawāt^e* "if he takes pity on him," *keteminawi* "take pity on him," *ketemīnō'nago^we* "I take pity on you," *ketemīnō'k^i* "he takes pity on thee," *nenī'cwiketeminā'gōpen^na* "we (excl.) are both pitied." From the above it follows that *-aw-* appears as *-ō-* before *-n-*, *-t-*, [in final syllables], *-^dtc-*, *-'k-*; as *-ā-* before *-g-*, *-t-* [normally], *-'s-*. I have evidence to show that *-aw-* also has the same shifts before the same consonants (or their phonetic correspondents) in Cree, Sauk, Kickapoo, Shawnee, Ojibwa, Potawatomi, Ottawa, Algonkin, Peoria, Delaware, Penobscot, and Passamoquoddy. Hence it is quite certain that these shifts took place in the Algonquian parent language. I call attention to the fact that this is the first time in the history of American linguistics that phonetic shifts in the parent language of any American linguistic stock have been pointed out.

I have previously shown that *n* (or its phonetic equivalent) changes to *c* (or its phonetic equivalent) before *i* which is the initial sound of a new morphological unit in Sauk, Fox, Kickapoo, Shawnee, Menomini, Ojibwa, Algonkin, and Peoria. The change of *s* to *c* under the same conditions occurs in Sauk, Fox, Kickapoo, and Ojibwa. The interchange of *ă* and *ā* is found in Sauk, Fox, Kickapoo, Shawnee, and Peoria. Further researches may show that these shifts occur in other Algonquian languages also, and so perhaps may likewise be referred to the Algonquian parent language. The contraction of *-wA-* to *-ō-* occurs in a number of Algonquian languages, but the evidence of Cree is unfavorable to the theory that this particular shift is to be ascribed to the Algonquian parent language. As the shift occurs in languages which are geographically all contiguous it is possible the shift has simply spread, so as to be practically pan-Algonquian rather than proto-Algonquian.[3]

[3] See this JOURNAL 4: 402. 1914; Amer. Anthropol. n. ser. 15: 470. 1913; Internat. Journ. Amer. Ling. 1: 50. 1917.

RADIOTELEGRAPHY.—*Quantitative experiments with coil antennas in radiotelegraphy.* L. W. AUSTIN, U. S. Naval Radio Laboratory.

The use of large inductance coils for sending, receiving, and direction determination was first proposed by the late Professor Braun,[1] who carried out experiments at Strassburg on signals from the Eiffel Tower and gave the general theory of a coil used as an antenna.[2]

Received current measurements, such as the laboratory made some years ago for the verification of the theory of transmission between ordinary antennas, have now been made for closed coils. According to the theory, a rectangular vertical coil of N turns, height H and length L, is equivalent to two vertical antennas of effective height NH at a distance apart L, with their respective currents in opposite phase. Taking into account the phase difference due to the difference in path, either in sending to a point p, or in receiving from p, the effect will be the same as that of one antenna of height NH multiplied by the phase difference $2\pi \frac{L}{\lambda} \cos\theta$ where θ is the angle between the plane of the coil and the direction of p.[3]

Now, the expression for the received current in a receiving antenna, with an antenna sending sustained waves, is, disregarding absorption:[4]

$$I_r = 120\pi \frac{I_s h_s h_r}{\lambda d R} \qquad (1)$$

where I_s is the sending antenna current, h_s the effective height of the sending antenna, h_r that of the receiving antenna, λ the wave length, d the distance, and R the receiving antenna resistance, expressed in amperes, ohms, and meters. If either or both of the antennas is replaced by a coil, we must replace its

[1] BRAUN, F. Jahrb. Draht Telegr. 8: 1–132. 1914.

[2] Mr. KOLSTER, of the Bureau of Standards, has developed an excellent direction finder on this principle.

[3] ZENNECK. Wireless Telegraphy. 1915. p. 234 and note 307, p. 425.

[4] ZENNECK. Wireless Telegraphy. 1915. p. 248; Bur. Stand. Bull. 11: 70. 1914.

height by $NH 2\pi \frac{L}{\lambda} \cos\theta$ where NH is the height of the coil times the number of turns, and we find for a

Coil Sending and Antenna Receiving

$$I_r = 120\pi \frac{I_s N_s H_s}{\lambda d} \, 2\pi \frac{Ls}{\lambda} \cos\theta_s \frac{h_r}{R}$$

$$= 2369 \frac{I_s N_s H_s L_s h_r}{\lambda^2 d R} \cos\theta_s \tag{2}$$

In the same way for an

Antenna Sending and Coil Receiving

$$I_r = 2369 \frac{I_s h_s N_r H_r L_r}{\lambda^2 d R} \cos\theta_r \tag{3}$$

and for

Coil Sending and Coil Receiving[5]

$$I_r = 14880 \frac{I_s N_s H_s L_s N_r H_r L_r}{\lambda^3 d R} \cos\theta_s \ \cos\theta_r. \tag{4}$$

The effective height h of an ordinary antenna equivalent to any coil NH may be expressed if $\theta = o$, by

$$h = 2\pi \frac{NHL}{\lambda} = 2\pi \frac{\text{area} \times \text{turns}}{\lambda}. \tag{5}$$

The equations show that, other things being equal, if an antenna be used, both for sending and receiving, the received current falls off as the wave length, while if one coil be used, it falls off as the square of the wave length, and with two coils as the cube of the wave length.

The value of the constant in the equation for a sending coil requires some consideration. The value given assumes that as the radiated field grounds itself, it takes the form of a field formed by the coil and its image as in the case of an antenna. This is probably true, at least for a coil whose dimensions are large compared with its distance from the ground. In the case of reception, this question does not enter.

[5] Dr. DELLINGER, of the Bureau of Standards, has published coil formulas in practical units with slightly different constants in a confidential report for the Signal Corps, Radio Transmission Formulas, July 1917.

Signals from Arlington have been measured at the laboratory on two coils. One was a crossed coil direction finder mounted on the roof of one of the buildings, having 56 closely wound turns, a height of 1.82 meters and a length measured between the planes of the front and back vertical sections of 1.29 meters. The second coil supported from masts, had 7 turns 80 cm. apart and measured 21.6 × 24.4 meters, θ being 42°. The results are shown in tables 1 and 2.

TABLE 1

ARLINGTON ARC RECEIVED AT LABORATORY ON DIRECTION FINDER

λ Meters	Received Current Amp. Observed	Received Current Amp. Calculated	Difference	Per cent Difference
6000	$208.0 \cdot 10^{-6}$	$157\ 5 \cdot 10^{-6}$	50.5	24
7500	$128.1 \cdot 10^{-6}$	100.8	27.3	21
10000	$67.5 \cdot 10^{-6}$	56 7	10 8	16
I_s = 100 amp.	$N = 56$	$L = 1\ 29$ m.	$\theta = 0°$	
h_s = 71 m.	$H = 1.82$ m.	$R = 50$ ohms	$d = 7800$ m.	

TABLE 2

ARLINGTON ARC RECEIVED AT LABORATORY ON LARGE COIL

λ Meters	Received Current Amp Observed	Received Current Amp Calculated	Difference	Per cent Difference
4000	$8.78 \cdot 10^{-3}$	$7.38 \cdot 10^{-3}$	1.40	16
6000	3.71	3.28	0.43	12
7500	2.26	2.10	0.16	7
10000	1.23	1.18	0.05	4
I_s = 100 amp.	$N = 7$	$L = 24.4$ m.	$\theta = 42°$	
h_s = 71 m.	$H = 21.6$ m.	$R = 50$ ohms	$d = 7800$ m.	

TABLE 3

LARGE COIL AT LABORATORY RECEIVED ON ANTENNA AT ARLINGTON

λ Meters	Received Current Amp. Observed	Received Current Amp. Calculated	Difference	Per cent Difference
2800	$147.8 \cdot 10^{-6}$	$150.8 \cdot 10^{-6}$	—3.0	2
4890	50.5	49.5	1.0	2
I_s = 1 amp.	$N = 7$	$L = 24.4$ m.	$\theta = 42°$	
h_r = 71 m.	$H = 21.6$ m.	$R = 50$ ohms	$d = 7800$ m.	

Table 3 shows the current received on the antenna at Arlington from the large coil at the laboratory excited by a coupled-

bulb circuit. The received currents in all three cases were measured with shunted detectors and galvanometers,[6] calibrated and tested for proportionality between deflection and current squared in each experiment.

In each of the tables, for the sake of comparison, the results are reduced to a common value of sending current and a common receiving resistance.

The observed values in tables 1 and 2 are seen to be uniformly larger than the calculated. This is supposed to be due to an action of the coil as an antenna since an increase in the length of

TABLE 4

COMPARISON OF ANTENNAS AND COILS

λ (Meters)	Equivalent Effective Antenna Height (Meters)				
	10	20	30	40	50
	Coil Area × Turns (Meters)				
200	319	637	956	....	....
500	796	1592	2388	3184	3980
1000	1592	3184	4776	6370	7960
2000	3185	6370	9552	12740	15920
3000	4776	9552	14280	19100	23880
5000	7960	15920	23880	31840	39800
7000	11140	22280	33450	44580	55760
10000	15920	31840	47760	63700	79600
12000	19110	38220	57330	76440	95520
15000	23880	47760	71640	95520	119400
20000	31840	63780	95520	127400	159200

the leads increases this difference. When the lower side of the coil is on or close to the ground, there is also an effect due to radio frequency earth currents just as in the case of the ground antenna. The reason for the increased error at the shorter wave lenghts is not yet clear: The agreement of observed and calculated values in the case of the coil sending (table 3) is all that could be desired. From this, sending from a coil and re-

[6] This JOURNAL 8: 569. 1918.

ceiving on an antenna, seems to offer the most accurate method for determining antenna effective height.[7]

Table 4 gives the effective heights of antennas which are equivalent either for sending or receiving to coils of various area turns, calculated from equation 5.

The observations in this paper have been taken for the most part by W. E. Grimes, Chief Electrician (Radio), assistant in the laboratory.

[7] In experiments of this kind incorrect results may be obtained, if observations are made too near the natural wave length of the coil, as in the case the current distribution is no longer uniform on account of the effect of the distributed capacity.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

ANTHROPOLOGY.—*Seneca fiction, legends, and myths.* Collected by JEREMIAH CURTIN and J. N. B. HEWITT. Paper accompanying the 32d Annual Report of the Bureau of American Ethnology. Pp. 36–83. 1918.

This paper consists of 58 stories classified as "fiction," 21 legends, 14 traditions, 4 tales, 9 myths, and 1 note on native medicine collected from the Seneca Indians on the Cattaragus reservation in 1883, 1886, and 1887 by the late Jeremiah Curtin; 31 legends and myths of much greater average length obtained by Mr. J. N. B. Hewitt of the Bureau of American Ethnology in the autumn of 1896, the last three accompanied by native Seneca texts; 23 pages of notes; and a short but important interpretative introduction of 29 pages. In this last Mr. Hewitt gives a history of the Seneca tribe, describes and explains the material in general terms, laying stress upon the importance of distinguishing true myths and legends from popular and even indecent tales not confined by any means to primitive peoples; attempts and outline of Mr. Curtin's views regarding primitive mythology; and concludes with a short but interesting exposition of his own opinions upon that subject. J. R. SWANTON.

ELECTRICITY.—*Electrical characteristics and testing of dry cells.* Bur. Stand. Circ. No. 79. Pp. 44. 1919.

This circular summarizes the available information on dry cells. A brief description of the materials and methods of construction, and elementary theory of the operation of the cells is given. The various sizes and kinds of dry cells on the American market are described. The electrical characteristics of the cells and methods of testing them are discussed. In an appendix are given the proposed specifications for dry cells which have been prepared by the Bureau.

G. W. VINAL.

METALLURGY.—*Conservation of tin in bearing metals, bronzes, and solders.* G. K. BURGESS and R. W. WOODWARD. Bur. Stand. Tech. Paper No. 109. Pp. 9. 1918.

This paper gives practical suggestions for the conservation of tin in bearing metals, bronzes, and solders; much of the data having been obtained from questionnaires sent to representative manufacturers and users of the above named alloys. Tables are given showing the chemical composition and physical properties of many of the suggested alloys and also for service tests of genuine babbitt and a high lead bearing metal. Tentative recommendations for standard grades of bearing metal are also included.

Proper solders for various industrial uses are recommended and a new solder consisting of a preponderance of lead with small amounts of tin and cadmium is described. R. W. W.

PHYSICS.—*Preliminary determination of the thermal expansion of molybdenum.* LLOYD W. SCHAD and PETER HIDNERT. Bur. Stand. Sci. Paper No. 332. Pp. 9. 1919.

The thermal expansion of an exceptionally pure specimen of molybdenum (99.85 per cent) was determined from —142° to +305° C. A short description of the apparatus and of the method used in obtaining high and low temperatures is given.

The results are shown in the form of tables, from which were computed, by the method of least squares, the following two empirical equations which satisfy the observations:

$L_t = L_0(1 + 5.15\, t \times 10^{-6} + 0.00570\, t^2 \times 10^{-6})$ and

$L_t = L_0(1 + 5.01\, t \times 10^{-6} + 0.00138\, t^2 \times 10^{-6})$

where L_t is the length of the specimen at any temperature t within the proper range; in the first case +39° to —142° C, and in the second case +19° to +305° C. The probable error of the length computed from these equations is less than 3×10^{-6} per unit length. P. H.

OPTICS.—*Optical conditions accompanying the striae which appear as imperfections in optical glass.* A. A. MICHELSON. Bur. Stand. Sci. Paper No. 333. Pp. 5. 1919.

Striae are conveniently divided into two classes; first those which appear as isolated bright streaks; second, those in which such streaks are numerous, forming bright irregularly continuous bands. Optical investigation with two forms of interferometers show that the former

are due to laminae of smaller index and of thickness of the order of a hundredth of a millimeter. They do not seriously affect the optical qualities of lenses or prisms. The second class of striae in general does not affect the optical performance; but, in the case of lenses and plane parallel plates, etc., in which the light traverses the striae at approximately normal incidence, the performance may be quite as good as with a perfect specimen. A. A. M.

TECHNOLOGY.—*The table of unit displacement of commodities.* Bur. Stand. Circ. No. 77. Pp. 67.. 1919.

This circular showing (1) the number of pounds per cubic foot as packed for shipment, (2) the number of cubic feet of space required for a short ton, (3) the number of cubic feet of space required for a long ton, and (4) the manner in which the material is packed, lists several hundred commercial commodities alphabetically. Appendixes give special information concerning automobiles, canned fruits and vegetables, and fresh fruits and vegetables.

This table has been prepared to meet an immediate demand for such information and will be revised and augmented from time to time as further data are obtained. The Bureau will, therefore, be pleased to receive information, criticisms, and suggestions from those interested in the table. H. M. Roeser.

TECHNOLOGY.—*Solders for aluminum.* Bur. Stand. Circ. No. 78. Pp. 9, pls. 2. 1919.

The use, serviceability, method of application, and composition of solders for aluminum are discussed in the light of special tests made at the Bureau of Standards on commercial and other compositions of solders. All soldered joints are subject to rapid corrosion and disintegration and are not recommended except where protection from corrosion is provided. Suitable compositions for solders are obtained by the use of tin with the addition of zinc or both zinc and aluminum within wide percentage limits. Solders are best applied without a flux. The higher the temperature at which the "tinning" is done, the better the adhesion of the tinned layer. A perfect union between solder and aluminum is very difficult to obtain, but the joint between previously tinned surfaces may be made by ordinary methods and with ordinary soft solder. Only the tinning mixture need be special. Tables of the composition of many solders are given. J. F. Meyer.

TECHNOLOGY.—*Tests of hollow building tiles.* BERNARD D. HATHCOCK and EDWARD SKILLMAN. Bur. Stand. Tech. Paper No. 120. Pp. 29. 1919.

These tests were made upon the types and sizes of tiles most commonly used in practice, and were carried out with the idea of studying their strengths and the relations existing between their various properties, especially those introduced by the kinds of clays used, the method of manufacture, and the positions in which they are laid. The principal tests discussed are those of compression and absorption which together total approximately 250. Strain readings were taken upon some with an 8-inch Berry strain gage for moduli determinations. The testing machines used were of the Olsen Universal type.

The results obtained show the loads at incipient failures, the maximum compressive strengths, and the moduli of elasticity of the various types and size of the tiles tested on end, on edge, and flat. Relationships are established between the moduli of elasticity and the compressive strengths, the colors of the tiles and their compressive strengths, the colors of the tiles and their moduli of elasticity, the percentages of absorption and the compressive strengths, and the percentages of absorption and the colors of the tiles. B. D. H.

MAMMALOGY.—*East African mammals in the United States National Museum.* Part 2. Rodentia, Lagomorpha, and Tubulidentata. N. HOLLISTER. U. S. Nat. Mus. Bull. 99, part 2. Pp. i–x, 1–184, pls. 1–44, fig. 1. May 16, 1919.

This second volume of a report on the mammals from Eastern Equatorial Africa contained in the collections of the National Museum lists 4,863 specimens of rodents, hares, and aardvarks, all but 100 of which were collected by the Smithsonian African Expedition, under the direction of the late Col. Theodore Roosevelt, 1909–10, and by the Paul J. Rainey African Expedition, 1911–12. The richness of the National Museum collection of East African mammals is well illustrated by the fact that in the two parts of this work so far published, dealing only with six orders of mammals, are listed 6,696 specimens, including 142 types; representing 349 valid species and subspecies. The plan of arrangement of the text adopted in the first volume has been followed throughout, and the geographical limits are the same. A list of all localities with index references to an accompanying map; generic and specific synonymies; type localities and location of type specimens; critical notes on distribution, habits, nomenclature, and taxonomy; lists of stations where each form was collected; and full tables of measurements of specimens are included. The skulls of all type specimens are figured natural size. It is hoped that a third volume, containing reports on the primates and the several orders of ungulate mammals, may complete the series. N. H.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES.

The 127th meeting of the Academy was held in the Assembly Hall of the Interior Department the evening of Friday, June 7, 1918, the occasion being an address by Professor WILLIAM S. FRANKLIN, of the Department of Physics, Massachusetts Institute of Technology, Cambridge, Massachusetts, entitled *Some needed lines of research in meteorology.* This address, which was informally discussed by Messrs. C. F. MARVIN and W. J. HUMPHREYS, has since been published in the Monthly Weather Review for October, 1918 (46: 449–453. 1919), under the title, *A much needed change of emphasis in meteorological research.*

The 128th meeting of the Academy was held jointly with the Chemical Society of Washington at the Administration Building of the Carnegie Institution of Washington, the evening of Thursday, January 9, 1919. Dr. F. B. POWER, retiring President of the Chemical Society, delivered an illustrated address on *The distribution and character of some of the odorous principles of plants.* This lecture has subsequently been published in the Journal of Industrial and Engineering Chemistry (11: 344–352. April, 1919).

The 129th meeting of the Academy, the twenty-first Annual Meeting, was held at the Administration Building of the Carnegie Institution of Washington, the evening of Tuesday, January 14, 1919, with President LYMAN J. BRIGGS in the chair. The minutes of the last annual meeting were read and approved.

The Corresponding Secretary, Dr. R. B. SOSMAN, reported that the membership on January 1, 1919, consisted of 6 honorary members, 4 patrons, and 506 members, one of whom was a life member. The total membership was 516, of whom 315 resided in or near the District of Columbia, 193 in other parts of the United States and in Canada, and 8 in foreign countries. The net gain for the year was 37. During the year the Academy lost by death 8 members: HENRY ADAMS, March 27, 1918; FRANK BAKER, September 30, 1918; GROVE KARL GILBERT, May 1, 1918; JOHN HARPER LONG, June 14, 1918; WILLIAM BATTLE PHILLIPS, June 7, 1918; RICHARD RATHBUN, July 16, 1918; CHARLES RICHARD VAN HISE, November 19, 1918; and HENRY SHALER WILLIAMS, July 31, 1918. The Board of Managers held 12 meetings during the year. The principal matters of general interest acted on by the Board have been reported in the JOURNAL. Among these matters

of general interest was the adoption by the Board of a definite limit of resident membership based upon the scientific population of Washington as recorded in the "Red Book" of the Academy. The membership is limited by this action to twenty per cent of the scientific population, or one in five. This, it is believed, will give additional emphasis to the fact that the Academy recognizes, by election to its membership, original research and scientific or engineering attainment. The Committee on Membership has given a great deal of time and care to the selection of candidates during the past year, and it is fitting that this public acknowledgement should be made of the Academy's indebtedness to that committee.

The Corresponding Secretary's report then reviewed briefly the objects of the Academy, as stated in its articles of incorporation, comparing these objects with the accomplishments of recent years.

The Recording Secretary reported upon the ten public addresses given under the auspices of the Academy during the year, most of which had been published in full in the JOURNAL. The lecture by Professor FRIDTJOF NANSEN, entitled *Changes in oceanic and atmospheric temperatures and their relation to changes in the sun's activity* was published in the JOURNAL as an author's abstract (8: 135–138. March 4, 1918).

The Treasurer, Mr. R. L. FARIS, submitted a report covering the last four months of the year, a report for the period from January 1 to August 31, 1918, having been submitted by his predecessor, Major WILLIAM BOWIE. A recapitulation for the year showed total receipts, \$6,594.76; total disbursements, \$9,168.18, including \$2,500.00 expended for Liberty Bonds; cash balance on hand Dec. 31, 1918, \$411.39. The Auditing Committee, consisting of Messrs. C. N. FENNER, J. A. FLEMING, and G. N. COLLINS, reported that the statement of the Treasurer was in full agreement with the accounts and with the securities on deposit.

Dr. A. KNOPF read the report of the Board of Editors.

The report of the tellers, Messrs. E. G. ZIES, F. WENNER, and ROBERT B. SOSMAN, was read by the Corresponding Secretary. The tellers reported that the mail ballot had resulted in the election of the following officers for 1919: *President*, F. L. RANSOME; *Corresponding Secretary*, ROBERT B. SOSMAN; *Recording Secretary*, WILLIAM R. MAXON; *Treasurer*, R. L. FARIS; *Non-resident Vice-Presidents*, C. K. LEITH and J. A. BRASHEAR; *Members of Board of Managers, Class of 1922*, C. G. ABBOT and W. F. HILLEBRAND.

The following Resident Vice-Presidents nominated by the affiliated Societies were then elected: *Anthropological Society*, GEORGE M. KOBER; *Archeological Society*, ALEŠ HRDLIČKA; *Biological Society*, HUGH M. SMITH; *Botanical Society*, WALTER T. SWINGLE; *Chemical Society*, ATHERTON SEIDELL; *Electrical Engineers Society*, P. G. AGNEW; *Society of Engineers*, MORRIS HACKER; *Entomological Society*, S. A. ROHWER; *Society of American Foresters*, RAPHAEL ZON; *Geological Society*, F. H. KNOWLTON; *Historical Society*, ALLEN C. CLARK; *Medical*

Society, WILLIAM GERRY MORGAN; *Philosophical Society*, W. J. HUMPHREYS. The National Geographic Society had nominated no Vice-President.

The newly-elected President, Dr. F. L. RANSOME, then took the chair and the retiring President, Dr. LYMAN J. BRIGGS, delivered an address entitled, *The resistance of the air*. This will be published in a later number of the JOURNAL.

The 130th meeting of the Academy was held in the Assembly Hall of the Cosmos Club, the evening of Thursday, January 30, 1919, the occasion being an illustrated lecture by Major F. R. MOULTON, U. S. A., on *The duration of the stars*. Beginning with illustrations showing the principal observatories of the United States and the apparatus by which solar and stellar phenomena have been studied and photographed, the lecturer showed photographs of the moon and of the sun, the one an example of a completely dead world, the other an example of a world which is giving off great quantities of energy and is very far from a state of equilibrium. The source of the sun's energy was discussed and shown to be a result neither of chemical reactions nor of the energy released by the contraction of an aggregate of particles. The latter source would permit the sun a life of at most a few million years, whereas geological and biological evidence demand periods of one hundred million years or more. The source of the sun's energy and its probable life cannot at present be estimated.

After showing diagrams illustrating the relative size of the moon, earth and sun, and the relative size of the orbits of the planets as compared with the distances of the so-called fixed stars, the lecturer passed to a consideration of the probable life of those stars. The problem of the life of star clusters is one that can be dealt with mathematically, and the lecturer calculated the probable period that must have elapsed in order that a more or less heterogeneous collection of stars might, by their mutual gravitation, be brought into the form now found in many of the recognized clusters. In view of the immense distances involved in the dimensions of these clusters, it follows that even a single passage of one star from one side to another of such an aggregate would take a million years; and the total time necessary to form the aggregate as it is now seen must be of the order of several thousand million years.

An interesting digression at this point covered some of the lecturer's work during the war, on the trajectories of projectiles and the best form of projectiles to obtain maximum range. The problems involved in this work were mathematical problems, in many ways similar to the mathematical problems of the astronomer with which the speaker had just been dealing, and he showed in a very practical way the wide applicability of mathematics as a working tool whether in the hands of the scientist or the engineer.

The lecturer finally considered the possible structure and location of certain nebulae which have been made the subject of much study in recent years. These may be distant galaxies equal in magnitude to the

galaxy of which the sun is a member. As the age of star clusters, as clusters, within our own galaxy may be measured in thousands of millions of years, it may become possible to estimate the age of the galaxy itself in enormously magnified time units in the same sense in which we measure the distances of the stars in terms of light years rather than in terms of our usual standards of length. And, finally, we may pass from the contemplation of the age and extent of our galaxy to that of the age and extent of these great aggregates of galaxies, or super-galaxies, which are by no means beyond the scope of the human mind.

The 131st meeting of the Academy was held at the Assembly Hall of the Cosmos Club, the evening of Tuesday, February 18, 1919. Prof. ROBERT F. GRIGGS, of the Ohio State University, Director of the National Geographic Society Katmai Expeditions, delivered an address on *Katmai and the Ten Thousand Smokes.* The lecture, which was profusely illustrated by lantern slides, reviewed the more general features of this remarkable region, which have been made familiar through the very interesting series of illustrated articles published by the speaker in the National Geographic Magazine, and dealt also with some of the more technical aspects of the subject as discussed in several recent papers published in Volume 19 of the Ohio Journal of Science, under the titles, *The recovery of vegetation at Kodiak* (pp. 1–58), *Are the Ten Thousand Smokes real volcanoes?* (pp. 97–116), *The great hot mud flow of the Valley of Ten Thousand Smokes* (pp. 117–142), *The character of the eruption as indicated by its effect on nearby vegetation* (pp. 173–209).

The 132d meeting of the Academy was held jointly with the Philosophical Society of Washington at the Assembly Hall of the Cosmos Club, the evening of Saturday, March 15, 1919. Dr. H. D. CURTIS, of the Lick Observatory, Mount Hamilton, California, delivered an illustrated address on *Modern theories of the spiral nebulae.* This lecture has subsequently been published in the JOURNAL (9: 217–227. April 19, 1919).

The 133rd meeting of the Academy was held at the Assembly Hall of the Cosmos Club, the evening of Thursday, March 20, 1919. Lieut. Col. JOHN R. MURLIN, U. S. A., Director of the Division of Food and Nutrition, Sanitary Corps, U. S. Army, delivered an illustrated address on *Food efficiency in the United States Army.* "The United States, in conjunction with her Allies, has waged war effectively. Many people are concerned to know also whether the war has been conducted *efficiently*, which is a very different matter. It may be safely said that in one respect at least we have done far better than in any previous war, *viz.* in the nutritional care of the soldier.

"Army regulations lay a clear responsibility for the character of the food and quality of the cooking upon the Medical Department. It has always been a routine matter of inspection by medical officers to pass upon the sanitation, including the character of food and quality of cooking, of the mess. Feeling this responsibility, in view of the

rapid expansion of the army Surgeon General William C. Gorgas organized in his office, in August, 1917, a Division of Food and Nutrition. This continued as an independent division until after the signing of the armistice. This Division commissioned and trained 113 officers who made nutritional surveys of all the large camps in this country and 40 of them were sent to France to be assigned one to each division of combatant troops as nutrition officers. Just before the signing of the armistice a request was received that all subsequent divisions should have nutrition officers assigned them from this side. After the nutritional surveys had been completed nutrition officers were stationed, one in each camp, to act as inspectors and advisors on all food matters, chiefly on matters relating to the proper construction of menus and the proper use and conservation of food. In short, the function was what might be termed that of food engineers.

"The nutritional surveys have shown for the first time what is the actual average consumption of food by healthy soldiers kept at hard work throughout the training period. The average consumption for 427 messes scattered throughout all the training camps in the United States and covering all periods of the year is 3633 calories per man per day, distributed as follows: 14 per cent protein, 31 per cent fat, and 55 per cent carbohydrate. In addition to this the average soldier in something over 300 surveys has consumed 365 calories, which he purchased from the canteen. This added to the consumption from the mess makes a total food consumption of 3998 calories. The surveys also showed for the first time a definite seasonal variation in food consumption. They showed likewise a progressive and consistent improvement in food conservation up to the signing of the armistice, at which time discipline and morale suffered a distinct diminution resulting in greater waste of food.

"In comparison with the garrison ration authorized in army regulations as the basis for the subsistence of one man for one day, the amount of food actually consumed leaves a margin of fully 20 per cent. The Division of Food and Nutrition recommended a reduction of this margin to 10 per cent, but the recommendation was not adopted by the General Staff.

"The surveys have demonstrated marked physical improvement in the soldiers during the period of training. For example, at Camp Devens the 303d Field Artillery exhibited in a period of five months an average gain in weight of more than six pounds, due to "muscling up." There was also a distinct gain in height, much of which no doubt was due to "straightening up."

"The lecture was illustrated by lantern slides and motion pictures, showing methods of food inspection, methods of serving, of dishwashing, of baking and handling of bread, and of feeding sick and wounded soldiers." (*Author's abstract.*)

William R. Maxon, *Recording Secretary.*

The 813th meeting was held at the Cosmos Club, February 1, 1919; President HUMPHREYS in the chair; 68 persons present. The minutes of the 812th meeting were read in abstract and approved.

Major FRED E. WRIGHT presented the first paper on *War time development of the optical industry*. (No abstract).

The second paper was by Mr. E. D. WILLIAMSON on *Temperature and strain distribution in glass*. The paper was illustrated by lantern slides.

Abstract: When a temperature gradient is set up in a solid, stresses result, owing to the unequal expansions of the various parts. The same is true of a viscous liquid, except that in the case of the latter there is a slow yield to the forces and in time the stresses and strains would vanish for that temperature distribution. At any time, then, there is a specific temperature distribution (dependent on the previous heat treatment) for any piece of glass, under which the glass is unstressed. If this temperature distribution be known the stresses produced when the temperature becomes equal throughout the mass can be calculated from elasticity data.

The paper dealt in detail (1) with the nature of the temperature gradients produced by uniform heating or cooling, at a constant rate, of the surface of solids of the following shapes, *viz*, slab, square rod, cylindrical rod, brick, short cylinder, and sphere; and (2) with the stresses set up in solids whose unstressed temperature distribution is that considered in (1). The stress relations were treated in full for the case of a sphere only.

The next paper was by Messrs. A. Q. TOOL and J. VALASEK on *Some characteristics of optical glasses in the annealing range*. This paper was presented by Mr. TOOL and was illustrated by lantern slides.

Abstract: In order to carry out the process of annealing glass efficiently a thorough knowledge of its various properties in the range of temperatures employed is necessary. In this respect the viscosity of the glass is very important, since any information as to its magnitude and variation with the temperature enables one to calculate the time required for the stresses to relax to any predetermined ratio of their initial value and to draw some conclusions as to the best cooling procedure. The term annealing temperature is used here to designate that constant and uniform temperature, consistent with the most efficient annealing procedure, at which the glass should be held while the stresses disappear. This temperature is determined by a study of the relaxation of stresses in a sample of glass at various temperatures. The two types of methods which have been employed for this purpose involve either a determination of the rate of decrease of internal forces by means of the double refraction exhibited, or the measurement of the rate of deformation of a suitable piece of glass under externally applied forces.

A form of the first type, often recommended for practical testing, was tried after some modification. Briefly, it consisted of heating a glass

cylinder with polished ends at a constant rate between crossed nicols and noting the temperature at which the double refraction began sensibly to diminish and also the temperature at which it vanished rapidly. It was found by experiment that the lower temperature gave good results as an annealing temperature and that the glass could be held at the higher temperature for a reasonable time without serious deformation.

Maxwell's "relaxation time" for the internal stresses in unannealed glass was determined at various temperatures by measuring the constants of the elliptical polarization by means of a modified Stokes elliptic analyzer.

In measurements of the second type, the stretching and bending of glass strips under load was employed, following Twyman and others.

The results indicated that the relaxation time not only depends on the temperature and the kind of glass, but also that larger stresses will relax more quickly. Stretching and bending gave practically the same results but the optical method gave considerably larger values, the discrepancy varying with the kind of glass. For large and equal stresses there was a better agreement.

Twyman's empirical exponential law for the change in the relaxation time with temperature holds quite closely for small temperature ranges. The constant in the exponential term appears to increase with the temperature and vary considerably with the glass. The most efficient method of cooling seems to be such that the rate increases exponentially according to the same law, as long as the stresses in the glass remain at all times below the breaking stress.

A phenomenon which may be of considerable importance in annealing and other processes in glass manufacture as well, was an apparent endothermic transformation found when careful heating curves were taken by means of differential thermocouple.

Mr. C. G. Peters has shown that this effect is accompanied by a very marked increase in the thermal expansion coefficient. This would appear to make it advisable to carry out the annealing below the region of this effect. It occurs in general, immediately following the temperature at which double refraction begins sensibly to diminish. It was found in all the optical glasses tested as well as many others.

Lately Mr. M. So has published similar results for some Japanese and other glasses. He failed however to observe a corresponding effect on cooling which had been the first indication of it observed in this laboratory.

A very plausible explanation would appear to be that the rapid heating disturbs the equilibrium between the components existing in the glass, which, in connection with the rapid decrease of viscosity, tends to re-establish itself with corresponding rapidity causing the thermal effects observed.

Discussion: Major WRIGHT stated that the temperature ranges cited by the authors agreed very closely with those found by him. Mr.

LITTLETON spoke on some of the characteristics of Pyrex glass. The paper was also discussed by Messrs. WHITE and PETERS.

The last paper of the evening was by Mr. L. H. ADAMS on *The annealing of glass*.

The paper was illustrated by lantern slides.

Abstract: The class of materials known as glasses is peculiar in many ways. At ordinary temperatures glasses are as hard, rigid, and elastic as ordinary solids, but when heated they gradually become softer and change without discontinuity into viscous and finally into thin liquids. During cooling the reverse process takes place and there is therefore a long range of temperature in which so-called solidification takes place. It is primarily due to this fact that cooled objects of glass acquire internal strain.

Optical glass must be free from strain, first because if the strain is excessive the glass may fracture when handled or when heated again, and second because the surfaces of a badly annealed lens or prism may gradually warp and thus impair the definition of the finished instrument.

For the practical annealing of optical glass it is sufficient to know for several temperatures the time required for the removal of strain. The necessary measurements have been made for nine kinds of optical glass and the application of the results to the annealing of optical glass in the factories has met with entire success.

Discussion: Mr. WHITE inquired if the method of annealing glass by holding it at a given temperature for a rather long time and then subjecting it to sudden cooling had not been introduced by Williamson and Wright. Mr. WILLIAMSON stated that his use of the method was due to the fact that it could be easily carried out by ordinary glass-workers and with the available furnace equipment. Major WRIGHT stated that the method had been rather unconsciously adopted.

The 815th meeting was held at the Cosmos Club, March 1, 1919; President HUMPHREYS in the chair; 30 persons present. The minutes of the 814th meeting were read in abstract and approved.

Mr. W. P. WHITE presented the first paper on *Change of state in solids—facts and theories*. The paper was illustrated by lantern slides.

Abstract: Changes of state in the solid, that is, changes of crystalline form, are from thermodynamic necessity like the change of state solid-liquid, that is, melting, in that the production of the high temperature form is always accompanied by an absorption of heat, but they show great variety in many phenomena. Nearly every law or rule which has been set up for such transformations has been shown to be abundantly violated. For example, in cases where of two forms both can be cooled to absolute zero, it is demonstrable that the high temperature form must at the temperature of inversion have the greater entropy, which involves that at some portion of the temperature scale below that point its specific heat must be higher, and the supposition is natural that the specific heat would be higher at all temperatures. In 40 per

cent of the investigated cases, however, the high temperature form at the inversion temperature has a lower specific heat; that is, its specific heat after being higher reverses and becomes lower again.

So, also, excellent atomic theories have accounted for the fact that of two forms the one of larger volume has the larger specific heat, but it turns out that in 70 per cent of the investigated cases it is the more dense form which has the larger specific heat. Again, it is a general rule that as bodies are compressed their power to resist further compression increases, but out of 27 cases of inversion 17 had the form of smaller volume more compressible. Finally, the high temperature form, being produced by an absorption of heat, that is, by doing work against attractive forces, would be expected to have a larger volume. In 25 per cent of the known cases even this expectation is not realized.

In order to explain this last surprising circumstance, Bridgman (whose experimental work has furnished the above results) points out that we must suppose atoms to have shapes other than spherical with centers of attraction situated elsewhere than in the center, but he points out that the nonspherical form means merely that the centers of repulsion (which by determining the resistance of the atom to penetration by other atoms determine what we think of as its boundary), must be distributed in a way which is very far from spherical symmetry. It is idle to assign definite patterns to these distributions of centers of force, but the fact is clear that while with atoms in any given arrangement a slight compression involves the doing of work against the repulsive forces, the rearrangement of atoms involved in a change of state may produce changes of volume to which the change in energy bears no correspondence. There is merely a 3 to 1 probability that they will correspond in sign. About one solid substance in three is estimated to show changes in crystalline form.

In some work done by the speaker it turned out that the quartz inversion, which has been known to be preceded by an abnormally large and progressive change in volume and various crystalline properties, also manifests an absorption of heat which is quite out of relation to the work done in expansion, unless we suppose that the compressibility is extraordinarily modified. Hence all the phenomena of this change, which is detectable over a range of 500 degrees or more, have the characteristics of a change of state, except that we do not appear to have two different forms in equilibrium at the same temperature, as we do in most other cases. The promptness of these changes affords a remarkable contrast to other changes of state between quartz and other forms of silica, which are unusually sluggish.

Discussion: This paper was discussed by Messrs. WILLIAMSON, SOSMAN, BICHOWSKY, and HUMPHREYS.

Mr. F. B. SILSBEE then presented a paper on *Some peculiarities of electrical conduction in porcelain.* This paper was illustrated by lantern slides, and has been published in this JOURNAL (9: 252).

Discussion: Mr. L. J. BRIGGS asked if electrodes other than those of molten solder had been used. Mr. WHITE inquired concerning the ef-

fect, on the "polarization" of increasing the thickness of the porcelain plates, also whether a saturation test could not be utilized to determine the possible functioning of electrons.

In reply, Mr. SILSBEE stated that platinum electrodes had also been used but with similar results; that no experiments had been made to test the effect of increasing the thickness of the porcelain plates; and that he did not think the saturation test could be made owing to the introduction of thermal complications due to actual heating of the porcelain, by the currents even before the currents ceased to be proportional to the applied potential-differences.

Mr. SOSMAN suggested the possibility of finding a solution of the problem in a study of the glass in the porcelain. The paper was also discussed by Messrs. WILLIAMSON and BICHOWSKY. Mr. AGNEW commented on the great variety of causes given for the failure of airplane engines, and the frequent lack of consistency between explanation and evidence.

The 817th meeting was held at the Cosmos Club, March 29, 1919; President HUMPHREYS in the chair; 80 persons present. Minutes of the 815th and 816th meetings were read in abstract and approved.

The first paper was persented by Mr. W. R. GREGG on *Trans-Atlantic flight from the meteorologist's point of view*, and was illustrated by lantern slides.

Abstract Inasmuch as weather conditions constitute a vital factor in the success or failure of trans-Atlantic flight, it is essential that these conditions be known as accurately as possible, in order that an aviator may know beforehand his "margin of safety" and may make his plans accordingly. The purpose of the paper is, therefore, briefly to present (1) a statement giving the present state of our knowledge relative to average surface meteorological conditions over the portions of the North Atlantic between Newfoundland and Ireland and between Newfoundland and Portugal via the Azores; (2) a similar statement as to free air conditions, particularly at altitudes of 500 to 1000 meters; and (3) an analysis showing the assistance that may be rendered by the winds, providing an aviator, with this in mind, carefully selects his time for flight.

Under the first and second headings conditions of temperature, humidity, cloudiness, precipitation, fog, pressure and winds are briefly summarized, this summary being based upon such few observations as have been made at sea and to a greater extent upon those made over adjacent land areas. In the application of the latter due consideration has been given to the essential differences between marine and continental climates, particularly with reference to free air conditions.

In the third part of the paper the necessity of having observations at the time of flight is pointed out. If such observations are available and if the airspeed of the machine is known, the meteorologist is able quickly to indicate the successive directions toward which the airplane should be headed, in order that it may keep to any desired course;

also, the resultant speed along that course, or the total time required for making a flight.

Conditions of pressure and wind that would be favorable for eastward and westward flights along the two routes are briefly discussed, and tables are given showing the average number of days, monthly, seasonal and annual, that are favorable for such flights. The figures in these tables are based upon an examination of daily marine weather maps covering a period of ten years. The results of this study show: (*a*) at an altitude of 500 to 1000 meters conditions are favorable for an eastward trip approximately one-third of the time, the percentage being slightly greater along the northern than along the southern route; (*b*) at greater altitudes the percentage of favorable days materially increases, especially along the northern route; (*c*) for the westward trip the percentage of favorable days is so small as to make trans-Atlantic flight in this direction impracticable until the cruising radius of air-craft is increased to such an extent that they are relatively independent of wind conditions; (*d*) there is little choice as to season, for, although the prevailing westerlies are stronger in winter than in summer, yet, on the other hand, stormy conditions are more prevalent in winter, the net result being about an equal percentage of favorable days in the two seasons. The transition seasons, spring and autumn, show a slightly smaller percentage than do summer and winter. For full publication of this paper see Monthly Weather Review, February, 1919.

Discussion: The paper was discussed by Messrs. BOWIE, AULT, HUMPHREYS, BROOKS, and HAZARD.

Mr. C. F. MARVIN presented the second paper on *The flight of aircraft and the deflective influence of the earth's rotation.* The paper was illustrated by charts.

Abstract: Objects moving freely in a horizontal manner over the earth's surface are deflected constantly to the right in the Northern hemisphere by a force which at airplane speeds, say 40 meters per second, and at latitude 50 degrees, amounts to .447 dynes per gram of moving matter.

The purpose of the paper was to indicate the amount by which an aircraft flying in still air may be carried off any desired course by the action of this small force, especially when a compass is the only guide followed in holding the course.

The speaker showed that a residual or resultant force, in addition to the deflective influence, almost constantly exists in assumed straight-away flying and arises from the reactions between the airplane and the air. The pilot has no knowledge of or control over this force, which, nevertheless, dominates the flight and operates to turn the machine from its course, now to the right, now to the left, in an irregular and entirely accidental manner. Repeated rectifications of the course are necessary, and it was assumed for purpose of quantitative analysis that on the average the pilot rectifies the course every 60 seconds of the flight.

Although the accidental forces dominate the flight and necessitate frequent rectification, nevertheless these tend to average out and their sum to become zero. The same is true of accidental side slipping effect. Therefore the problem resolves itself into finding the displacement by the deflective influence when operating during the interval between rectifications.

It was shown the aggregate effect tended to carry the craft to the right of its course in the Northern Hemisphere by a small angular amount given by the equation,

$$\theta = \frac{360}{86164} t \sin \varphi$$

in which t is the time in seconds between rectifications and φ is the latitude.

The angle θ could be regarded as a compass correction and the error of flight eliminated by steering to the left of any specified course by the angular amount θ, values of which for different latitudes were given varying from over 5 minutes of arc at latitude 20 degrees to nearly 15 minutes at 80 degrees. It was also shown that the linear displacement from course varied as the $\sin^2 \theta$ or nearly as the square of the time between rectifications and in a 10-hours' flight would amount to nearly 5000 meters.

While not a part of the main purpose of the paper, it was pointed out that the equations lead to the deduction that gliding could be prolonged if executed in a right-hand instead of a left-hand turn of large radius. Also, turning to the right when climbing is more efficient than turning to the left.

Following the second paper Mr. L. J. Briggs spoke briefly on the application of certain other dynamical principles to the flight of aircraft.

S. J. Mauchly, *Recording Secretary.*

BIOLOGICAL SOCIETY OF WASHINGTON

The 595th regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, April 5, 1919; called to order at 8 p. m. by President Smith; 55 persons present. Eight informal communications were presented.

W. P. Taylor: The Olympic elk, *Cervus roosevelti*, thought to have been extirpated in Washington State outside of the Olympic Mountains, has recently been reported from the following localities within Pacific County; two bands of 40 each on the Nasel River, one band of about 50 on North River, one band of 25 on the Nemah River, two small bands on the South Fork of Wallapa River, and one small band on the main Wallapa River. There are said to be about 175 animals in all.

A. S. Hitchcock: Attention called to two recent botanical publications, and copies of the books exhibited: Prof. J. F. Rock, *A monographic study of the Hawaiian species of the Lobelioideae*, and Prof. E. D. Merrill, *Rumphius's Flora Amboinensis.*

H. C. OBERHOLSER: Remarks on ornithological activities during 1918 in which year 26 subspecies and 3 distinct species (one of the latter an extralimital straggler) had been added to the North American avifauna, while 8 forms were removed from the list.

T. S. PALMER: Remarks on the rare New Caledonian bird, kagu, *Rhinochitus jubatus*, but few specimens of which are found in collections, none in the U. S. National Museum, although it is frequently seen in zoological gardens there being at present a specimen living in the collection of the New York Zoological Society.

T. S. PALMER: Remarks on the number of bison in North America thirty years after the first census in 1889. There are at present 7300 individuals of which 4300 are in Canada as against a total of 1091 in 1889. There were born in 1918 1100 calves. The government owns eight herds, embracing 850 animals.

A. WETMORE: Remarks on the shape and size of the pupils of birds, particularly of the black skimmer, *Rynchops niger*, in which the contracted pupil is a vertical slit.

N. DEARBORN: Remarks on the apparent preference by a pair of bluebirds for a newly-painted blue-colored box over an old weather-worn greenish one.

H. SMITH: Exhibition of drawings of the deep-sea fish, *Gargariscus semidentatus*.

The regular program consisted of two communications:

AGNES CHASE: *Oil grasses and their uses in perfumery.* Four grasses, native of the East Indies, furnish essential oils. All belong to the Andropogoneae. *Cymbopogon nardus*, citronella grass, and *C. citratus*, lemon oil grass, are not known in the wild state. They are cultivated throughout the tropics, but on a commercial scale mostly in the East Indies. From 1909 to 1917 experiments were carried on with *C. citratus* by the Department of Agriculture in Florida. It could be grown on sandy pineland at a fair profit. In these two species the sterile plants, cut above the base, are distilled. The oil is used for scenting soap and for adulterating other oils. *Cymbopogon martini*, rusá grass, is not cultivated, but harvested from the wild plants common in India. Only the inflorescence is distilled. Rusá, or palmarosa, oil is used chiefly for adulterating attar of roses. This is the *Andropogon schoenanthus* of pharmacopoeias, but not the real species. *Anatherum zizanioides*, Khus-Khus or Vetiver, is both wild and cultivated, now spread throughout the tropics and grown sparingly in southern Louisiana and southern California. The oil is obtained from the roots. Its volatility is low and it is used as a fixative for other oils. The roots are woven into mats, screens, fans, etc., in India, and are made into perfume powder.

Discussion by Messrs. H. M. SMITH, and A. S. HITCHCOCK.

R. M. ANDERSON: *Recent zoological exploration in the western Arctic.* Dr. Anderson, who was in Washington to attend the organization meeting of the American Society of Mammalogists, gave an account of several years of zoological exploration along the western coast of Arctic America. He described his itinerary and referred to the difficulties of zoological

collecting in the Arctic, calling attention to the limitations of travel during the short summer and the ease of travel in winter. In winter, however, animals of migratory and hibernating habits are not encountered. He described the topography of the territory explored, the distribution of the animal and plant life in it and the migrations of some of the forms. He discussed in particular the muskoxen, the yield of long-fibered wool, and contemplated attempts to domesticate them. Among other interesting discoveries was a spider whose nearest relatives occur on certain mountain summits in the United States. Attention was called to the relatively high summer temperature and the twenty-four-hour period of daylight and to its stimulating effect on plant life and to the fact that Arctic animals have to endure a relatively hot summer climate during part of their year. The collections brought back are being studied by various specialists and the published reports will occupy several octavo volumes. Discussion by Messrs. T. S. PALMER, H. M. SMITH, W. P. TAYLOR, R. M. LIBBEY, E. A. PREBLE, W. B. BELL, and H. C. OBERHOLSER.

M. W. LYON, JR., *Recording Secretary*.

ENTOMOLOGICAL SOCIETY OF WASHINGTON

The 321st meeting of the Society was held in the Auditorium of the Cosmos Club, on April 3, 1919. Thirty-three members and 4 visitors were present. President SASSCER presided.

PROGRAM

GIBSON, EDMUND H.: *Some war-camp insect problems*. This was an informal account of the insect problems which the speaker as a captain in the Sanitary Corps had to contend with at Camp Humphries, Virginia. Captain Gibson spoke of the methods adopted in controlling mosquitoes, flies, and bedbugs, and illustrated his talk by maps, charts, and photographs.

For the control of mosquitoes both drainage and oiling were employed as well as the occasional removal of the floating debris in the small bays along the river front. As a result of the mosquito eradication a well-known malarial district was converted into a section comparatively free from mosquitoes; and as shown by charts of the Public Health Service the camp made the best record of any of the cantonments situated in malarial regions.

Against the flies, traps and the treating of manures with gasoline flame were resorted to. As a result of this work no epidemics of dysentery or typhoid occurred in the camp. Captain Gibson brought out the fact that in the observations on the results of the fly work this camp was the only one in the country in which the various species of flies were considered separately.

A very serious infestation of bedbugs was controlled and the bugs entirely exterminated by two applications of kerosene followed by fumigation with carbon disulphide.

Most of the discussion consisted of questions, Captain Gibson's answers to which are incorporated in the above summary of his remarks.

KOTINSKY, JACOB: *The fundamental factors of insect evolution.* (A translation). This paper was a translation from the Russian of Chetverikov. The author advanced the theory that the development of insects has been from large to small, supporting this idea by paleontological evidence. This was contrasted with the development of mammals, the mammoth forms of which reached their greatest development and died out, the present forms having developed from smaller forms. He found the reason for this contrast in development lines in the difference in the skeleton, the exoskeleton of the insects combined with their small size having protected them from their enemies and permitted the development of the tremendous numbers that exist.

In the discussion that followed it was pointed out by Mr. ROHWER that just as at present it is the largest insects of a region that are collected first and the smaller forms later, so it is with fossil insects. Up to the present most of the fossil forms discovered are large, but that there were minute contemporary insects is shown by the Florissant deposits, from which many very minute forms have been taken. Mr. BUSCK expressed the opinion that in the Lepidoptera the primitive forms are as a rule small. Dr. BAKER commented on the effect of climatic conditions and abundance of food supply in the determination of the sexes of insects, and stated that the size of insects can be reduced by limitation of food supply. Mr. MARLATT suggested that perhaps the different conditions of air, water, and soil in ancient times tended to produce animals of immense size.

R. A. CUSHMAN, *Recording Secretary.*

The U. S. Coast and Geodetic Survey reports the completion of the new outline map of the United States on the Lambert Conformal Conic Projections; scale, 1 : 5,000,000; dimensions, 25 × 39 inches; price, 25 cents. This map is intended merely as a base to which may be added any kind of special information desired. It is based on the same system of projection (the Lambert projection) as that which was employed by the armies of the allied forces in the military operations in France. For an area of the shape and position of the United States, this projection has several marked advantages over the Mercator and the Polyconic projections. Throughout the larger and more important part of the United States, that is, between latitudes $30^1/_2°$ and $49°$, the maximum scale error is only one-half of one per cent. The standard parallels of the map of the United States are latitudes $33°$ and $45°$, and upon these parallels the scale is absolutely true. The scale for any other part of the map, or for any parallel, can be obtained from Special Publication No. 52, page 36, U. S. Coast and Geodetic Survey.

The Office of Drug and Oil Plant Investigations, Bureau of Plant Industry, is installing a laboratory at Arlington Farms to study the technology of fats and vegetable oils, in connection with its projects on oil-yielding crops and utilization of waste.

The Coast and Geodetic Survey steamer *Surveyor* left Norfolk, Virginia, on April 21 en route to the Pacific via the Panama Canal. Deep-sea soundings will be made from off Chesapeake entrance to the Bahamas and from Jamaica across the Caribbean Sea.

The Twelfth Annual Conference of Weights and Measures Officials, composed of delegates from the States and larger cities of the United States, met at the Bureau of Standards on May 21–24, 1919, 27 States being represented. The object of these conferences is to bring about uniform laws and regulations regarding the inspection of commercial weights and measures and also to discuss matters of technique and procedure. Among other results of the Conference was the adoption of a resolution favoring the metric system. Officers elected for the following year were: *President,* S. W. Stratton, Director of the Bureau of Standards; *First-Vice President,* Chas. G. Johnson, State Superintendent for the State of California; *Second Vice-President,* Thure Hanson, Commissioner of Weights and Measures of Massachusetts; *Secretary,* L. A. Fischer, of the Bureau of Standards.

Dr. Paul Bartsch, of the National Museum, returned in May from a trip to the Florida Keys and the Dry Tortugas, where he has been conducting breeding experiments under the joint auspices of the Smithsonian Institution and the Carnegie Institution of Washington.

Professor L. C. Graton, of Harvard University, came to Washington in June and expects to spend several months in the Bureau of Internal Revenue of the Treasury Department, in charge of copper mine valuation under the Income Tax Unit of the Bureau.

Mr. C. T. GREENE, of the Bureau of Entomology, has recently been made honorary assistant custodian of Diptera in the Division of Insects of the National Museum and is assisting Dr. ALDRICH in the arrangement of the Museum's collection of Diptera.

Major F. R. MOULTON, formerly of the Ordnance Department, U. S. A., received his discharge from the Army and returned to the University of Chicago in April.

Captain EDWIN H. PAGENHART, U. S. R. (Engineers), has received his discharge from the Army and has returned to the Coast and Geodetic Survey.

Mr. E. A. SCHWARZ and Mr. H. S. BARBER have recently returned from a trip to the Florida Everglades, where they collected many insects, which will be added to the collections of the National Museum. One very interesting Scolytid beetle belonging to a tropical genus has already been described by Mr. Schwarz.

Major SAMUEL A. TUCKER, of the Chemical Warfare Service, and Washington representative of the newly-organized Chemical Foundation which took over enemy-owned patents during the war, closed the Washington office in May and has returned to New York.

Mr. R. J. WIG, formerly of the Bureau of Standards, and chief engineer of the concrete-ship department of the Emergency Fleet Corporation during the war, has resigned from the Fleet Corporation to go into private engineering work at San Diego, California.

④ JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 9 JULY 19, 1919 No. 13

PHYSICS.—*"Physical" vs. "chemical" forces.* P. V. WELLS, Bureau of Standards. (Communicated by S. W. Stratton.)

In his remarkable memoir on the constitution of solids and liquids, Langmuir[1] considers in some detail those forces which are concerned in the structure of matter, stating their characteristics with great clearness. But unfortunately he adopts definitions of "physical" and "chemical" forces connoting a narrowness to the term "physical" which is quite unhappy. I realize, however, that his purpose in this is to emphasize the relation of many terms and phenomena usually regarded as distinct.

Science has arrived at a stage in its evolution where the classification between physics and chemistry appears artificial. Of course all classification is necessarily arbitrary and appears so especially at the boundaries between classes. There must, therefore, be confusion and difference of opinion among those who approach the study of what may perhaps be called *twin fields*, such as physical chemistry or chemical physics, from different points of view. The appropriate attitude in such matters seems to be to avoid the artificial issue by classification and nomenclature derived from a viewpoint common to both.

In view of the historical significance of the words "physical" and "chemical," their use in classifying forces appears rather unnatural. A less artificial nomenclature is that derived from the fundamental theory of the constitution of matter common

[1] I. LANGMUIR. Journ. Amer. Chem. Soc. 39: 1848. 1917.

to both physics and chemistry, according to which forces are classified as (1) *molar*,[2] (2) *molecular*, (3) *atomic*, and (4) *electronic*. There is little anthropomorphic in these words, and they center the attention on the phenomena. The classification is qualitative in the sense that no quantitative relations of these forces to energy have yet been defined. The electron theory of atomic structure, however, dispels much of the vagueness surrounding many of the forces, and raises into further prominence the conviction of Faraday that there is but one fundamental type of force.

Electronic forces may be defined as those which maintain the negative or valence electrons and the positive nucleus in equilibrium as a single system. Similarly, atomic forces may be defined as those which maintain two or more atoms in equilibrium as a single system; molecular forces as those which maintain two or more molecules in equilibrium as a single system; and molar forces those which maintain two or more masses in equilibrium as a single system. Each group of forces may be regarded as the residual fields of force remaining unsaturated in the smaller systems constituting the components of the system under consideration.

For the description of certain phenomena the molar theory is sufficient, but soon a stage is reached at which the phenomena must be considered in more detail. The system considered is then restricted to groups of molecules. This system is in its turn further restricted to atomic groups, and so on. The important point is that each theory includes all those preceding as special cases, as the result of simplifying approximations, or as arising from statistical considerations. The more closely one wishes to examine the nature of the extended system the more the point of view approaches that of the restricted system. The key to the nature of molecular forces, for example, is to be found in atomic considerations. This is the point particularly emphasized by Langmuir in his paper.

[2] *Molar* is derived from the Latin *moles*, a large mass. In the Century Dictionary *molar forces* are defined as those producing motions between large masses, *molecular forces* those between molecules, but which are insensible at sensible distance.

Whatever the nature of the fields of force, the effect of neighboring systems would be expected to be more definite the more discrete the structure. Thus electronic forces are definitely characteristic of the nature of the element, showing the finite differences of the periodic system. Atomic forces show more continuity, only two distinct types occurring, corresponding to primary and secondary valence. These may be called *primary* and *secondary* atomic forces. Molecular systems have lost so much of their discreteness that combinations of molecules do not follow the laws of definite and multiple proportions. In such phenomena as molecular association and surface structure, the discreteness of atomic constitution begins to give place to statistical continuity. Moreover, even in these phenomena, the forces are relatively so weak that molecules are not usually regarded as permanently grouped together.

In order to avoid the troublesome conflicts which are involved in the use of the words physics, physical chemistry, and chemistry, for many purposes it would be convenient to classify these portions of science into molar theory or *molics*, molecular theory or *moleculics*,[3] *atomics*, and *electronics*.

Molics deals only with continuous quantities and ideal discontinuities such as surfaces. This is the province of classical physics. In molecules the statistical nature of molar quantities must be considered. For instance, actual surfaces between distinct phases are not regarded as mathematical surfaces of discontinuity, but as possessing a molecular structure, so graphically shown by Langmuir and his predecessors. Such phenomena as molecular association, condensation and those connected with colloids and ions in gases are also typically molecular in that finite groups of molecules are involved and the range of forces is not large compared with the distances between molecules. Moleculics thus includes much of what is often called physical-chemistry. The complexity of molecular systems limits the application of quantitative methods, in spite of the great advances in statistical mechanics.

[3] The accent might be placed upon the penult, as in *monatomic*.

The great fertility of the atomic theory has produced such a mass of systematic knowledge that the province of atomics is easily defined. Moreover, the definiteness and comparative simplicity of atomic systems makes classification easy. This is still more striking in the case of electronics, which perhaps may be even more productive of systematic knowledge than atomics has been. To some, attention to nomenclature is considered trivial, but early in his career Faraday remarked the importance of clever definitions which he always recorded, and demonstrated by his example the close relation between the progress of science and its nomenclature. Moreover, if the main purpose of science is economy of thought, it is as necessary to systematize and classify facts already known, as to discover new facts only to have them buried unappreciated.

BOTANY.—*Notes on the genus Dahlia, with descriptions of two new species from Guatemala.* W. E. SAFFORD, Bureau of Plant Industry.

The impression that the many "double-flowered" dahlias of our gardens are forms created by modern horticulturalists from single-flowered types is erroneous. In the earliest illustration of plants belonging to this genus, made more than three centuries and a half ago, only double-flowered forms are represented. Indeed, the genus itself was based by Cavanilles on *Dahlia pinnata*, a plant with double heads identical in form with certain "peony-flowered" dahlias of modern catalogues. Francisco Hernandez, the *protomedico* of Philip II, sent by his sovereign in 1570 to New Spain to study its resources, figured at least three dahlias under the Aztec names *Acocotli*, *Cocoxochitl*, and *Acocoxochitl*, all of which are derived from *cocotli*, signifying, like the word "syringa," a hollow-stemmed plant; *acocotli* literally translated becoming "water-cane," or "water-pipe;" *cocoxochitl*, "cane-flower" or "hollow-stem flower": and *acocoxochitl*, "water-pipe-flower." It is interesting to note, in connection with this vernacular name, that it was also applied by the Aztecs to plants of distinct families, including umbellifers, one

of which, an aromatic Ligusticum with a hollow stem and fleshy roots resembling those of the genus Dahlia, was erroneously figured under the same heading as the two dahlias first described.

Fig 1—Duplex-flowered Dahlia, called Acocotli by the Aztecs After Hernandez (1575).

Hernandez was not a botanist, but grouped his plants according to their uses and appearance, rather than to their botanical affinities.[1] Two of his figures, representing dahlias of the type

[1] In connection with the hollow-stemmed umbellifer of Mexico, it may be of interest to note that from the hollow stems of the allied Cicuta the shepherds of Virgil and Theocritus made pan-pipes, or syrinxes, "*disparibus septem compacta cicutis fistula*"

now called "Duplex," with leaves like those of *Dahlia variabilis*, were poorly drawn (see fig. 1), but a third figure, reproduced in the accompanying illustration (fig. 2) was that of a Dahlia with

Fig. 2.—Peony-flowered Dahlia, called Acocoxochitl by the Aztecs. After Hernandez (1575).

flowers of the "peony type" and with leaves resembling those of *Dahlia glabrata*. This figure was accompanied in the Roman edition of Hernandez's work by a very brief and inadequate description. In the Madrid edition[2] it is described under the

[2] Vol. 1, p. 14, cap. 24.

heading "*De Acocoxochitl seu flore Acocotli*," as having flower heads with yellow disk and purple ray-florets, after which the author goes on to say that many more forms of Acocoxochitl occur in Mexico, differing from one another in the size and color of the flowers, some of them white, others yellow, others purple or red, others white tinged with purple, or perhaps yellow tinged with red, and a great many other kinds, in some cases with double or multiple whorls of ray flowers, either forming circles or clustered in compact bunches (*manipuli*). The roots he describes as fleshy, or succulent, and fascicled like those of asphodel, with a resinous or somewhat sweetish artichoke-like taste.

Although both the flowers and leaves of cultivated dahlias show considerable variation, yet there are certain features in both which are more or less uniform. In one group of the genus the ray-florets are broad and flat; in another they have a tendency to become involute or quilled, while in a third the margins are bent backward or revolute. These distinct groups are further characterized by their foliage, the leaves of which, whether simple, pinnate, or bipinnate, have a peculiar texture and vary similarly in form. Very little attention is paid to the leaf-characters of dahlias either in standard works on horticulture or in florists catalogues. A well defined species like *Dahlia coccinea*, for instance, may be found under the heading *leaves once pinnate*, in spite of the fact that in the original drawing of the type plant the lower leaves of this species have their lower pinnae again pinnate. In consequence of this carelessness and also perhaps from the fact that the lower leaves of the forms figured in catalogues are seldom shown, some authors have gone to the extent of uniting into a single species Cavanilles' *Dahlia pinnata*, *D. rosea*, and *D. coccinea*.

In nearly all the monographs on the genus Dahlia hitherto published the different varieties have been grouped from the horticulturalists' point of view, according to the forms of the flowers, under such headings as "single, duplex, anemone-flowered, collarette, pompon, fancy, decorative, peony-flowered, and cactus dahlias," without identifying the single-flowered forms with botanical species (except perhaps in *Dahlia coccinea* and

Dahlia imperialis) or attempting to connect the "duplex" and double forms with their primitive single ancestors. It is very probable that the types upon which several species have been based were hybrid plants. *Dahlia pinnata* itself, the type of the genus, was probably a hybrid. In the Index Kewensis its name is discarded as a synonym for the subsequently described *D. variabilis*. In the same way the handsome *Dahlia juarezii* with large double heads composed of strap-shaped florets having their edges turning backward, in sharp distinction to the involute or quilled florets of the artificial-looking "pompon dahlias" and the broad, flat-rayed heads of the "century" type of modern catalogues, is also to be regarded as a hybrid. Dahlias with flowers identical in form with the type of *Dahlia juarezii*, the ancestor from which the "cactus dahlias" of our gardens have sprung, are no longer called "cactus dahlias" by specialists, but "cactus hybrids." One of the ancestors of *Dahlia juarezii* must have been a single flowered species, with eight revolute ray-florets. Such a plant has recently been discovered in the mountains of Guatemala by Mr. Paul Popenoe, in honor of whom it is purposed to name the species described below. In addition to this species Mr. Popenoe brought back with him a handsome tree Dahlia, already represented in the U. S. National Herbarium, but hitherto erroneously referred to *Dahlia imperialis* by some authorities and by others to *Dahlia variabilis*. This second species represented in the herbarium by two sheets collected in Guatemala by Mr. William R. Maxon, is described below under the name *Dahlia maxonii*.

There are several other undescribed species of the genus Dahlia in the National Herbarium, but there is no space within the limits of this paper to describe them. Indeed the whole genus should be carefully revised by a botanist familiar with closely allied genera of composites and the work should be based upon material collected in the elevated regions of Mexico and Central America where the plants are endemic, not upon garden-grown specimens. Much of the material in herbariums is incomplete, owing to the absence of characteristic lower leaves of the plants represented; and many of the specimens are in

bad condition, owing both to the difficulty of drying succulent plants like dahlias, which wilt as soon as gathered, and to the injury of the flower heads by insects.

Dahlia popenovii Safford, sp. nov. *Tepeacocoxochitl* (Nahuatl); *Papalotl, Tunaita* (Guatemala).

A herbaceous plant about 1 meter high with fascicled, fleshy roots and slender, erect, hollow, striated, purplish stems glabrate near the base and sparsely clothed above with minute, whitish, woolly hairs. Leaves membranaceous, opposite with the bases of the petioles connate, as in the rest of the genus, the lower ones (lacking in the type) described as bipinnate; the upper ones simply pinnate, usually 3-foliolate, or simple and deeply 3-lobed, with the leaflets or lobes decurrent on the rachis and winged petiole, sparsely clothed with short, stiff hairs; leaf-like bracts of the inflorescence simple, laceolate, acuminate, sessile; leaves of young seedlings simple, broadly ovate, with the base decurrent on the slender petiole. Inflorescence more or less corymbose, with the flower heads borne on long slender, petioles, erect or slightly curved at anthesis, at length recurved or nodding; peduncles 12 to 14 cm. long bearing one or two bracts, sometimes with a shorter-peduncled head issuing from the axil of the bract. Flower heads 6 to 9.5 cm. broad, those of the type with bright scarlet or cardinal rays and yellow disks; outer involucre calyx-like, as in the rest of the genus, composed of 5 spreading or recurved spathulate-oblanceolate bracts; inner involucre composed of about 10 erect, diaphanous, oblong scales, rounded at the apex, enlarging after anthesis; ray florets 8, sterile, widely spreading, rounded and abruptly pointed at the tip, revolute or turning backward along the margins as in forms of the "cactus" type of cultivated dahlias, disk florets hermaphrodite, tubular, mature achenia 12 or 13 mm. long, concealed by the thin, diaphanous paleae borne on the disk, these resembling the scales of the inner involucre and almost equal to them in size.

Type in the U. S. National Herbarium, no. 1010584, collected near San Lucas, Department of Zacatepequez, Guatemala, at an approximate altitude of 6600 feet, October 21, 1916, by Wilson Popenoe (no. 682).

This handsome species, which is probably an ancestor of the hybrid *Dahlia juarezii*, from which the "Cactus Dahlias" of our gardens have been derived, is named in honor of its discoverer, Mr. Wilson Popenoe, of the Office of Foreign Seed and Plant Introduction. It is represented by a single specimen, and by several seedlings propagated at Yarrow, Maryland, from seeds collected by Mr. Popenoe. In Mr. Popenoe's field notes he writes as follows:

Antigua, Guatemala, October 23, 1916.—On my way back from Guatemala City to this place I collected some wild dahlias about 2 kms. above Santa Lucia, at an approximate elevation of 6600 feet, where the plants were most abundant. I have not seen them as low

Fig 3 —*Dahlia popenovii*, showing two flower heads, mature fruiting head, upper leaves of mature plant and a single leaf of a young seedling, also a ripe achenium Drawn from type material and from a photograph of the flower by Mrs R E Gamble, Bureau of Plant Industry All natural size

as 5000 feet, but have found them up to 7000, which is as high as I have gone. I do not know how much higher they may occur. The plants observed near Santa Lucia grow to a height of about 4 feet. The stem is a dull greenish purple to purplish green, usually glabrous but sometimes with scattering hairs toward the upper portion. Leaves 2-pinnate near the base of the stem, 1-pinnate or simple above; leaflets of the lower leaves ovate acute, 2.5 inches long, 1.5 inches broad, remotely dentate, sparsely furnished with short bristly hairs, which are more scant beneath; rachis not exceeding 5 inches in length, often very short; petiolules 0 to 0.75 in. long. The flowers are 2 to 3.25 in. broad, with 8 ray florets, the latter sterile and orange brown or crimson in color, in some forms short and broad, in others long and narrow with the margins recurved or revolute, giving to the flower the appearance of a Cactus Dahlia, and contrasting with the other form having broadly spreading flat rays rounded at the tips.

From photographs of these contrasted forms it is evident that the latter species is the true *Dahlia coccinea* of Cavanilles, the type figure of which it exactly resembles.

Dahlia maxonii Safford, sp. nov. Tree Dahlia of Guatemala. *Tzoloj* (Kekchi); *Shikor* (Pokomchi); *Quauhacocoxochitl* (Nahuatl).

A tall plant with vertical terete hollow stem 3 to 5 meters high and 5 to 7 cm. thick, at length becoming woody, with joints at intervals formed by the clasping bases of the connate petioles of the opposite leaves. Leaves membranaceous, pale green beneath, deep green above, quite smooth or sparsely hairy, those of the inflorescence and on the upper part of the stem simple or pinnate, those on the lower portion of the stem bipinnate; leaflets lanceolate, terminating in a long slender point, the terminal leaflet narrowed and the lateral ones rounded and unequal at the base, with the blades more or less decurrent on the narrowly winged rachis, the margins dentate (the larger leaflets with 16 to 18 teeth on each side), the lower pair often bilobed and sometimes with an additional pair of small leaflets at the base, as in several other species of the genus; leaves of young seedlings simply pinnate, with the rachis scarcely or not at all winged. Flower heads peduncled, erect; peduncles 10 to 12 cm. long, those of axillary heads somewhat shorter and subtended at the base by simple caudate-acuminate leaf-like bracts narrowed at the base into a winged petiole 1 or 2 cm. long; involucre composed of two distinct series, the outer consisting of 5 green, fleshy, widely spreading, spathulate-ovate bracts obtuse at the apex 10 to 15 mm. long and 5 to 8 mm. broad, the inner of about 10 membranaceous diaphanous, oblong, scales rounded at the apex, overlapping before anthesis, at length erect, 18 to 20 mm. long and 8 to 10 mm. broad. Ray florets neutral, lavender-pinkish or lilac, ovate, flat, widely spreading as in the cultivated forms of the "century type," 4 to 5 cm. long and 2 to 3 cm. broad with the apex rounded or abruptly pointed; disk-florets hermaphrodite, often sterile, tubular,

Fig 4 —*Dahlia maxonii*, showing fully expanded flower, two unopened buds, disk floret, and achenium, together with a bipinnate and a simple leaf Natural size Drawn by Mrs R E Gamble

sharply 5-toothed, yellow, 10 mm. long; mature achenia, 1.5 mm. long.

Type in the U. S National Herbarium, no. 473271, collected at Socoyocté, Department of Alta Verapaz, Guatemala, January 16, 1905, by William R. Maxon (no. 3295).

DISTRIBUTION: Mountains of Alta Verapaz, Guatemala, and across the boundary into the state of Chiapas, Mexico.

This handsome tree dahlia is named in honor of Mr. William R. Maxon, collector of the type material. It is further represented in the U. S. National Herbarium by specimens from Sepacuité, Alta Verapaz, collected by George P. Goll (no. 224), Guatemala, without definite locality, by Heyde (no. 319) and Mrs. William Owen (no. 2a "Tzoloj"); in cultivation near Guatemala City by Wilson Popenoe (no. 728); and in the vicinity of San Cristobal, state of Chiapas, Mexico, at an elevation of 7000 to 8800 feet, by E. W. Nelson (no. 3173).

In Mr. Maxon's field notes he describes it as a plant "8 to 15 feet high; flowers lavender-pinkish, 4 inches across; buds and young shoots eaten as 'greens;' a very common plant." Mr. Popenoe's notes, dated Tactic, Alta Verapaz, Guatemala, December 16, 1916, are as follows:

"This tree dahlia is extensively used here for hedges. The stems are cut and inserted in the ground, projecting three or four feet; they take root and grow, and when the plants have reached ten or twelve feet in height they produce quantities of lilac-pink flowers, three to five inches broad. Just now they are in all their glory, and Tactic is brilliant with them. This impresses me as being an unusually fine decorative plant. It should be cultivated in the United States. In addition to the typical form, — single pink, — three others are known in this region. Some of them may be distinct species. The people say they are wild plants. One resembles the typical form except that it is quite double. Another is a single white, its flowers resembling those of the single pink in everything except color. The fourth form is double white. The flowers of this form are very handsome and are used by the Indians to adorn the images of saints which they keep in their houses. Don Matias Acevedo says that water contained in the hollow stems is medicinal. It is used here as a gargle in cases of sore throat. This plant is called *shikor* in Pokomchi, which is the language spoken in Tactic. In Kekchi, which is the language spoken throughout most of the Alta Verapaz, the name is *tzoloj*."

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

BIOLOGY.—*A sketch of the natural history of the District of Columbia, together with an indexed edition of the U. S. Geological Survey's* 1917 *map of Washington and vicinity.* W. L. McAtee. Bull. Biol. Soc. Washington 1: 1–142, maps 5. 1918.

The purposes of this publication are to present a brief biological history of the District of Columbia, to point out the best places for field work, and to supply geographical assistance. The earliest observation on the natural history of the region was made by Captain John Smith in the year 1608, who reported several kinds of mammals from this region, particularly bears and deer. The first information regarding the botany is furnished by Petiver, who in 1698 published some notes on plants sent him from Maryland. The first formal list of the plants of the District of Columbia was published in 1816, and from the 142 species then credited to this region, the list has increased until at the present time there are approximately 1600 species known from the vicinity of Washington.

Insects, of course, are more numerous here than any other group of animals, and beetles alone number 3000. Several hundred species, chiefly Diptera and Hymenoptera, have been described from material collected near Washington. Of other invertebrates there are known from the District of Columbia, 90 species of mollusks, 308 species of spiders, 10 phalangids, and 246 rotifers. Among the vertebrates, fishes have received more attention than any other group except birds, and there are now 94 species recorded from this region, several of which were described from local specimens. Owing to the presence of tidewater, a number of salt-water fishes are found there. Of batrachians there are 27 species, and of reptiles, 36. The birds of the District have been more carefully studied than any other group of vertebrates, and there is now a list of some 300 species and subspecies. Of mammals there are 41 species, 3 of which were originally described from specimens obtained near Washington. It is of interest to note that within historic times, the buffalo, elk, and puma were to be found near what is now

the City of Washington. The Indians of Algonquina stock who inhabited this region, all abandoned it about the year 1700.

The Fall Line, separating the Piedmont Plateau from the Coastal Plain, runs through the District of Columbia and acts as a more or less definite faunal barrier, most so in the case of plants and insects. Another interesting feature of this region is the numerous magnolia bogs and their relation to the pine barrens of New Jersey. Careful study of these bogs has shown that they possess a large percentage of the characteristic pine-barren plants, and that they now harbor these survivors of the plant waves that accompanied the successive depressions of the Atlantic Coast region. Furthermore, the absence of pine barrens from the District of Columbia is due only to the absence of extensive areas of suitable soil deposits. Other types of collecting ground about Washington, with mention of localities where such are to be found, together with some of the more desirable plants and animals to be obtained at each, are also given. One of the chief features of this bulletin is an indexed edition of the recent United States Geological Survey map of the District of Columbia and vicinity, to which a detailed index furnishes a ready means of reference. All the old collecting spots, archaeological sites, and the minor topographical details, are indicated, and it is thus possible to locate any place of biological or other interest in this region. HARRY C. OBERHOLSER.

GEOGRAPHY.—*The Canning River region, northern Alaska.* ERNEST DE K. LEFFINGWELL. U. S. Geol. Survey Prof. Paper No. **109**. Pp. 245. Pls. 35, figs. 33. 1919.

The report deals chiefly with the geography and geology of an area about 70 miles square south of Camden Bay on the Arctic coast of Alaska. In addition it gives facts and interpretations relating to many problems in other fields of science.

Under geography are described the Franklin mountains, Romanzof mountains, and some other parts of the Arctic mountain system. North of the mountains is the Anaktuvuk Plateau, a rolling tundra upland that slopes gradually seaward. The flat and almost featureless coastal plain rises very gradually from the Arctic Ocean southward to the Anaktuvuk Plateau. The coast line is generally straight and the land very low. The shore is characterized by low mud banks, shallow lagoons, sand spits, islands, and mud flats. Maps accompanying the reports present the first accurate chart of the north Arctic coast of Alaska from Martins Point to Colville River. In the mountains the

rivers flow through marked glacial troughs; in the upland through wide valleys; and in the costal plain nearly at the surface of the tundra. Canning River is 120 miles long; other large streams of the area are the Okpilak, Hulahula, and Sadlerochit.

Under Geology are described: Paleozoic, Mesozoic and Cenozoic rocks. Pleistocene glaciers extended from the mountains well down the valleys but did not reach the coast. Present glaciers are confined to the higher mountain valleys.

The occurrence of ground ice is described and the literature of this subject reviewed in considerable detail. The author concludes that the two varieties of ground ice most common in northern Alaska are formed by the burial of river ice by sediments, and the growth in place of vertical ice wedges. J. T. PARDEE.

MYCOLOGY.—*Further data on the susceptibility of rutaceous plants to citrus-canker.* H. ATHERTON LEE. Journ. Agr. Res. **15**: 661–665. 1918.

Inoculation tests made in the Philippine Islands with *Pseudominas citri* upon 24 species representing 20 genera of the family Rutaceae, show that 19 of the species are susceptible in greater or less degree. It thus appears that citrus-canker is not closely limited to the genus Citrus, but has a wide range of hosts among the Rutaceae.

Severinia buxifolia, Aegle marmelos, and *Balsamocitrus gabonensis* all close relatives of Citrus, may safely be called immune to citrus canker. *Xanthoxylum rhetsa* and *Triphasia trifolia* seem to be immune.

Chalcas (*Murraya*) *exotica, Atalantia disticha,* and *Fortunella* (*Citrus*) *japonica,* also closely related to the genus Citrus, are strongly resistant to citrus-canker.

Claucena lansium, Feronia limonia, Feroniella lucida, Chaetospermum glutinosum, Hesperethusa crenulata, Paramignya longipedunculata, Citropsis schweinfurthii, Atlantia citrioides, Eremocitrus glauca, Fortunella hindsii, Microcitrus australis, M. australasica, Toddalia asiatica, Evodia ridleyei, E. latifolia, and *Melicope triphylla,* of different relationships to the genus Citrus, all produce positive results when inoculated with *Pseudomonas citri,* at needle punctures. Of these, *Claucena lansium* and *Feronia limonia* develop infection very slowly, the others fairly quickly.

Chaetospermum glutinosa shows naturally occurring infections of citrus-canker and in the Philippines its susceptibility is easily greater than that of the sweet orange (*Citrus sinensis*). *Fortunella hindsii*

occurs naturally in South China, very much isolated from sources of citrus-canker infection. The abundance of cankers found on such trees gives rise to the theory that this species may have been an original wild host from which citrus-canker spread to cultivated species.

H. R. FULTON.

MYCOLOGY.—*The parasitism, morphology, and cytology of* Cronartium ribicola *Fischer*. REGINALD H. COLLEY. Journ. Agr. Res. **15**: 619–659. Pls. 48–53. December 23, 1918.

In the white pine the mycelium of the fungus makes its way between the cells of the phloem tissue, passes into the xylem along the rays, and in some instances works its way between tracheids. The severe damage to the tree attacked results from the driving out of the bark after formation of the aecia and a consequent girdling action. Before spore formation, the pine cells are quite tolerant of the presence of the hyphae of the parasite. The mycelium in Ribes leaves is scattered; haustoria are much less prominent and abundant than on the mycelium in the pine host. The damage to Ribes varies greatly according to the susceptibility of the species.

Pycnia are formed in broad layers just under the outer cork layers of the bark. The aecia, more deeply seated than the pycnia, are formed on the same general area as the pycnia, following the latter by one season. The aecial peridium is three to five cells thick. Uredinia are formed on the lower surface of the infected Ribes leaves, and are at first covered by a peridium one cell in thickness. The teliospores are produced in columns which in their young stages are identical with the young stages of the uredinia, having the same type of peridium. Every teliospore in the column may germinate.

The cytological processes agree very closely with those observed by previous investigators on other rusts. At the inception of the dikaryon at the base of the aecium, the union of two fertile cells regularly occurs, but a number of cases were observed where several cells formed a large placenta-like unit from which the aeciospore chains appeared to arise. The similarity of the processes of conjugate division in the dikaryon in the aecia, uredinia, and telia, suggests a stability of nuclear material throughout the dikaryon. The presence of centrosomes in the nuclei, and occurrence of a number of chromesomes in excess of two, is discussed and illustrated very fully. R. H. C.

MYCOLOGY.—*Physoderma disease of corn.* W. H. TISDALE. Journ. Agr. Res. **16**: 137–154. 1919.

The Physoderma disease of corn, which was discovered by Shaw in India in 1910 and by Barrett in the State of Illinois in 1911, is now known to be more or less prevalent throughout the United States as far westward as central Texas and Nebraska, and northward to southern Minnesota and New Jersey. It causes little damage except in the South Atlantic and Gulf Coast States and in the lower Mississippi Valley, where there is considerable rainfall accompanied by high temperatures. In these localities there may be as much as 10 per cent loss of grain.

At a distance the disease has the appearance of a true rust, but on close observation the two can be easily distinguished. The small reddish-brown spots on the blades, which are seldom more than 1 mm. in diameter, often coalesce to give the blade a rusty appearance. On the midrib, sheath, and culm, the spots are often as much as 5 mm. in diameter and may be almost black, due to the abundant production of dark brown sporangia in the tissues. The parenchyma tissues of the sheath may be entirely destroyed, leaving nothing but a shredlike mass of vascular fibers in the later stages. Plants have been seen to break over before maturity, due to a girdling of the lower nodes by the fungus.

The invaded cells are filled with dark brown zoosporangia, which live over winter in the old diseased plants and in the soil. These sporangia are carried by wind and spattering water to the young plants the following season where they are lodged behind the sheaths and in the buds. With sufficient free water and a high temperature (23° to 30° C.) they germinate by producing numerous uniciliate zoospores which come to rest in from one to two hours and germinate by threadlike hyphae which penetrate the epidermis of the host, invade a number of cells, and produce within them a large number of sporangia which make the disease evident.

The most probable means of control are careful sanitation and crop rotation. W. H. T.

MYCOLOGY.—*Apple scald.* CHARLES BROOKS, J. S. COOLEY, and D. F. FISHER. Journ. Agr. Res. 16:195–217. 1919.

Apple scald is a transportation and storage disease of apples. Green apples are more susceptible to the disease than mature ones, and apples from heavily irrigated trees more susceptible than those from trees receiving more moderate irrigation. The rapidity of the development of the disease increases with a rise in temperature up to 15° or 20° C.

Stirring the storage air has been found entirely to prevent the development of scald. Thorough aeration during the first eight weeks of storage was found more valuable than later ones. Apples packed in boxes or ventilated barrels have scalded less than those in tight barrels, especially when the storage room received an occasional ventilation. Ordinary apple wrappers have had no effect on apple scald, and paraffin wrappers but little, but wrappers soaked in various oils and fats have entirely prevented the disease. Accumulations of carbon dioxide (1 to 6 per cent) have not favored the development of scald but tended to prevent it. The experimental results indicate that apple scald is due to volatile or gaseous substances other than carbon dioxide which are produced by the apples themselves. They can be carried away by air currents or taken up by various absorbents. C. B.

PHYTOCHEMISTRY.—*The distribution and characters of some of the odorous principles of plants.*[1] FREDERICK B. POWER. Journ. Ind. Eng. Chem. 11: 344–352. April, 1919.

In this paper, which does not permit of a comprehensive abstract, the author indicates the chemical characters of the great variety of compounds to which the odor of plants is due, the distribution of these compounds among the different plants, and the methods by which they are obtained. Among the *cryptogamous* or flowerless plants, such as the algae, fungi, lichens, and ferns, there are very few which possess any marked or distinctive odor, whereas the *phanerogamous* or flowering plants contain such an exceedingly large number of odorous substances as to preclude a complete enumeration of them. These substances, many of which have been the subject of extended chemical study, are of such a diverse character as to include representatives of practically all the principal groups of organic compounds, comprising, for example, the hydrocarbons, alcohols, aldehydes, ketones, phenols and phenol ethers, acids, esters, and lactones. The odorous products of the plant are generally obtained by a process of steam distillation, and are then commonly known as essential oils or volatile oils, most of which are more or less complex mixtures, although frequently one constituent of them may largely predominate. Some of the essential oils are obtained by expression, such as those of the citrus fruits, notably the orange, lemon, and bergamot. In some cases the odorous principles of plants

[1] Abstract of an address of the retiring president of the Chemical Society of Washington. Delivered before a joint meeting of the Chemical Society and the Washington Academy of Sciences, January 9, 1919.

are of so delicate a nature that they can only be obtained in a tangible form by a process of maceration with a purified fat, known as *enfleurage*, whereby the perfume is absorbed and may subsequently be extracted with alcohol. As examples of this class there may be mentioned the flowers of the violet, jasmine, tuberose, jonquil, lily of the valley, and mignonette.

The various families of plants which have been considered by the author for the purpose of illustration include the *Coniferae, Gramineae, Palmae, Liliaceae, Iridaceae, Zingiberaceae, Orchidaceae, Aristolochiaceae, Annonaceae, Myristicaceae, Lauraceae, Cruciferae, Rosaceae, Geraniaceae, Myrtaceae, Umbelliferae, Ericaceae, Labiatae, and Compositae*. In connection with these groups numerous volatile products have been described with reference to the chemical character of their individual constituents. The preparation by synthetic methods of some of the odorous substances which occur in nature, or of compounds related to them which are largely used in perfumery, has also received consideration. F. B. P.

SPECTROPHOTOMETRY.—*The ultra-violet and visible transmission of eye-protective glasses.* K. S. Gibson and H. J. McNicholas. Bur. Stand. Tech. Paper No. 119. Pp. 47. 1919.

Many glasses are on the market and extensively advertised to protect the eyes from injurious radiant energy. Unfortunately, but little authoritative information concerning the properties of these glasses has been available. The public and even oculists and physicians have had little to guide them in selecting such glasses except the claims of makers and agents. One purpose of such glasses is to absorb the injurious radiant energy which is emitted along with the light from certain lamps, as well as from welding arcs and industrial furnaces, while transmitting sufficient light for vision. They thus act as filters. Another purpose in certain cases may be to absorb part of the light so as to reduce a blinding brilliance. Glasses of different types are required for different needs. The degree to which these glasses actually fulfill their avowed purpose can only be determined by measurements of their "transmission" (*i. e.*, the ratio of transmitted energy to the energy falling on them) for the various forms of radiant energy in question. This paper gives the results of such measurements made on a great number of glasses now on the American market. A suggested specification for eye-protective glasses is given. K. S. G.

TECHNOLOGY.—*Silica refractories. Factors affecting their quality and methods of testing the raw materials and finished ware.* DONALD W. ROSS. Bur. Stand. Tech. Paper No. 116. Pp. 84. 1919.

The quartz or amorphous silica of raw silica brick is gradually transformed to crystal forms of lower specific gravity when the bricks are burned during manufacture, and when subsequently heated in use. Dr. C. N. Fenner, of the Geophysical Laboratory of the Carnegie Institution, laid the foundations for the study of the silica refractories by working out the physico-chemical properties of the silica minerals. Mr. Spotts McDowell applied the results of this work in a study of the permanent, crystal changes taking place in silica refractories on being heated to temperatures usually attained in manufacture. He also studied the effect of such changes on the strength of the brick, and its tendency to spall (fly apart) when rapidly heated or cooled.

The writer took up the work at this point, in the hope of obtaining some practical applications. He has studied the changes in volume, porosity, and true specific gravity of most of the leading commercial brands of silica brick, and of the raw materials from which they are made, in conjunction with the crystal changes. The volume, porosity, and specific-gravity changes were obtained by computation from the dry weight of a piece, its weight when saturated with water, and its weight when suspended in water.

The porosities of the quartzites in conjunction with their appearance under the microscope, indicate that impervious, highly metamorphosed quartzites, having tightly interlocking grains, are more apt to be suitable for the manufacture of silica brick than porous quartzites which have rounded grains. The changes taking place on heating indicate that the best bricks would be produced in manufacture by an extended heating between 1250° C. and 1350° C. and a final gradual rise to higher temperatures. From the studies on commercial brick, it has been determined that the true specific gravity of a silica brick is a direct measure of the degree to which the brick has been burned, and in conjunction with the porosity, indicates approximately what the subsequent expansion of the brick in use will be. Thus, by a simple procedure, the manufacturer can keep an accurate check on the nature of the silica brick he is turning out, and in the same way the consumer can determine what to expect from them in use. D. W. R.

PROCEEDINGS OF THE ACADEMY AND AFFILATED SOCIETIES

GEOLOGICAL SOCIETY OF WASHINGTON

The 334th meeting of the Society was held in the Auditorium of the Cosmos Club on Wednesday evening, April 9, 1919, at 8.00 p. m.

PROGRAM

C. E. VAN OSTRAND: *Temperatures in some deep wells in the United States.*

During the past few years observations of temperature have been made in deep wells located in Texas, Oklahoma, Pennsylvania and West Virginia. The apparatus used in making the tests was capable of an accuracy of about 0.2 or 0.3° F. for depths of about 4000 feet; while for greater depths the error may have risen in a few instances to 0.5° F.

The depth temperature curves, instead of being a straight line, as would be expected from cosmological hypotheses, are generally curves with a marked convexity toward the axis of depth. In the case of the Goff Well, for example, the rate of temperature increase varies continuously from 1° F. in 97.5 feet at the surface, to 1° F. in 46.5 feet over the interval, 6000 to 7000 feet.

Temperatures at the same depth in the Texas and Oklahoma fields, differ widely from those in Pennsylvania and West Virginia. The temperature of the oil in two wells near Mannington, West Vriginia, is 83.2° F. at a depth of about 2900 feet. No record of oil temperature was obtained in the Southwestern fields but an extension to a depth of 3400 feet of the depth temperature curves of five wells in the vicinity of Ranger, Texas, indicates that the temperature of the oil in the rocks is about 135° F. The average rate of temperature increase at the surface for thirteen wells in Texas and Oklahoma, is 1° F. in 51.5 ± 0.8 feet; the same for twelve wells in Pennsylvania and West Virignia is 1° F. in 91.5 ± 1.2 feet.

E. W. BERRY: *Present tendencies in paleontology.*—It is difficult to get into a sufficiently detached frame of mind correctly to visualize the true position of the United States in the present status of paleontology. We undoubtedly exhibit a provincialism and a radicalism that goes with young nations as with young individuals. The future belongs to us if we keep our ideals high enough. The paleontologic sun is setting in Europe while the dawn is just breaking in America.

Progress in paleontology can only result from the action and reaction of the two parallel lines of human endeavor, namely, the accumulation of facts through exploration, research, and discovery, and the eluci-

dation of the accumulated facts through advances in philosophic interpretation. The accumulation of facts usually far outruns their interpretation. Stratigraphic paleontology cannot be divorced from biological paleontology without becoming sterile. Hisotorical geology is the idea we strive for. Loosely drawn genera and species are no longer useful. Progress depends on research. True research does not depend on subject matter but on method. I would wish to depreciate the tendency, rampant throughout the world, to seek a justification for research as a means towards some economic end. If the elucidation of each history and the origin and evolution of life on the globe are not of prime importance as ends in themselves; if the whence, and the why, and the whither are not supreme, then indeed has our lot fallen among evil days. I venture to hope that research will increase in both quality and amount, and that the day will speedily arrive when a first rate paleontologist can command a fair income in the successful practice of his profession.

E. T. Wherry: *Some practical applications of crystallography.*—This paper comprised illustrations of the application of petrographic methods to certain chemical problems, including the identification in foods of crystalline substances, such as magnesium ammonium phosphate which had been mistaken for glass; the control of the manufacture of explosives and dyes by optical study of their crystals; and the recognition of the nature of a peculiar type of crystallization in honey. It was illustrated by lantern slides made from photomicrographs.

The 335th meeting of the Society was held in the Auditorium of the Cosmos Club on Wednesday,April 23, 1919, at 8.00 P. M.

Program

G. W. Stose: *Manganese deposits of the Appalachian Valley of Virginia and Tennessee.*—The manganese deposits of the Appalachian Valley lie chiefly along its eastern border, but some occur within the open valley, and others among the ridges on the western side. The deposits are chiefly replacement deposits in clay and sand residual from disintegrated limestone and calcareous sandstone, and 10 different modes of occurrence have been observed. Eight of these are associated with specific, geologic horizons, which range from earliest Cambrian to the Carboniferous. Other deposits are along fault planes and in terraced stream gravels. Only 1 of the deposits is a carbonate ore, which replaces dolomite and slate.

The conclusions reached are that: 1, the localization of the deposits at certain horizons, is due to their derivation from certain sedimentary beds which were somewhat richer in manganese than sediments generally; 2, these richer zones occur at the base of formations and some are associated with glauconite, phosphate, eolean sand grains, and other detritus accompanying land waste at unconformities; 3, the original mineral was probably a carbonate of manganese, calcium, and iron; 4, the ores were concentrated by the solution of the original disseminated mineral, by meteoric waters, and redeposition in porous

layers or channels, replacing the sand and clay of the rock; 5, this concentration was favored by periods of long denudation and deep weathering and was therefore most extensive on old peneplain surfaces; 6, the purity of the ore is controlled largely by the purity of the rock replaced; 7, some of the richer minerals were apparently derived from other minerals by dehydration after deposition, and some psilomelane appears to have been deposited with quartz while it was in a gelatinous state; 8, only one of the deposits, which passes downward into carbonate ore, was a replacement of the bedrock below the zone of surface weathering.

H. D. MISER: *Manganese deposits of the Batesville district, Arkansas.*—The manganese ores consist of oxides and generally occur in irregular shaped masses from less than one pound to 22 tons in weight, with rough surfaces. Most of the masses are in clay; the others are in limestone, shale, chert, and sandstone, and there is much evidence that the manganese oxides of which the masses are composed have replaced all of these inclosing materials. The oxides have been derived from manganese-bearing carbonates near the surface and do not extend below the permanent water level of the district. The workable deposits occur in the nearly horizontal Fernvale limestone and Cason shale of Ordovician age and in residual clays which were mainly derived from these two formations. Most of the masses in the clays are residual, having been freed from the above-named formations by their decomposition; the others have been formed by the replacement of the clays by manganese oxides.

The Cason shale was laid down in shallow marine waters on an old land surface and was probably the source of all of the manganese. The manganese was apparently deposited as a carbonate in the shale, and since then there have been two principal periods of reconcentration, the first taking place during one or more of several stages of emergence and erosion that occurred between the Ordovician and Carboniferous periods, and the other about the time of the completion of the Upper Cretaceous or early Tertiary peneplain whose approximate elevation is marked by many of the even-crested hills of the district. During both periods the manganese was concentrated in the Cason shale and much of it was carried in solution from the shale down into the Fernvale limestone. Synclines were present during the earlier period, as well as the last one, and they probably offered favorable conditions for the concentration of the manganese ores, as is shown by the fact that most of the ores occur in synclines.

E. L. JONES, JR.: *Manganese deposits of the Colorado River Desert Region.*—Deposits of manganese ore have been recently exploited in the desert region adjacent to Colorado River, that extends from the Big Bend near Las Vegas, Nevada, to Yuma, Arizona.

The deposits are fillings in veins and brecciated zones and replacement deposits. The veins and brecciated zones cut all the rocks of

the region ranging from schist and granite of pre-Cambrian age to basalt and conglomerate of Quaternary age, and the replacement deposits are in sandstone and tuff beds of Tertiary age. The ores consist of the oxides psilomelane, pyrolusite, manganite, and wad. Calcite generally accompanies the manganese oxides, and iron oxides, barites, and gypsum occur in some of the deposits. Quartz does not occur except as a constituent of rock fragments inclosed in the veins and as unreplaced grains of the sandstone. The source of the manganese oxides is obscure but in some of the deposits the manganese oxides are believed to have been derived from the decomposition of manganiferous minerals in overlying rocks and deposits by meteoric waters. In other deposits the ore bodies may be residual from manganiferous calcite deposited by rising hot solutions in the fissures.

J. T. PARDEE: *Manganese deposits of the Northwestern States.*—At Butte, Montana, lodes formed along steeply pitching fractures in granite are characterized by manganese minerals in a zone peripheral to the central copper zone. The arrangement of these zones suggests a central deep source from which the metals were carried upward and outward. Rhodochrosite, the carbonate of manganese, forms workable bodies from which more than 60,000 tons of ore were mined in 1918. At Philipsburg, Montana, lodes cut Paleozoic limestone and intrusive granite. In the limestone near the granite, large irregular chambers filled with manganese oxides are found along the lodes. During 1918 and 1919 they yielded more than 200,000 tons of high grade ore. The manganese oxides are derived from the oxidation of rhodochrosite which was introduced during a late phase of the lode mineralization. Small deposits of the same origin as those at Butte and Philipsburg occur in the Tintic and Erickson districts, Utah; the Siegel and Ely districts, Nevada; Pleasant Valley, Oregon; and Omak, Washington.

Deposits at several other places belong to a class whose manganese was derived from more or less disseminated or obscure sources. The extensive deposits in the Olympic mountains of Washington are possibly of sedimentary origin though they have been greatly modified by regional metamorphism. The deposits near Green River, Utah, were concentrated during the weathering of a manganese-bearing limestone bed in the McElmo formation.

E. F. BURCHARD: *Managanese-ore deposits of Cuba.*—Manganese ore is found in Cuba, in Oriente, Santa Clara, and Pinar del Rio Provinces, but in Oriente Province only does it occur in large commercial quantities. In Oriente the important deposits are in two areas, one north of Santiago de Cuba, the other south of Bayamo.

The manganese ore of Oriente occurs in proximity to areas of volcanic rock, but the deposits of the other two provinces, which are small and unimportant, are remote from volcanic areas. The ore is found in the oxidized zone, mainly near the surface, but in places extends be low groundwater level. The deposits are in sedimentary rocks of

upper Eocene age, such as foraminiferal limestone, shaly, glauconitic sandstone, conglomerate, and waterlaid andesitic tuff, and in igneous rocks such as latite-porphyry and latite. Eocene time was characterized in the area of Oriente Province chiefly by subsidence, with active volcanoes, causing interbedding of volcanic and sedimentary rock.

The ore consists of some or all of the oxides pyrolusite, psilomelane, manganite, and wad, and braunite has been noted, but as a rule the individual minerals are not readily distinguished. The deposits are of three general types according to their associations: deposits in bedded rocks, deposits in irregular siliceous masses (jasper, bayate) that occupy openings in both sedimentary and igneous rock, and deposits of nodules and fragments in clay. The "bedded" deposits comprise several varieties, one of the most common having been formed by partial replacement by manganese oxides of portions of tuff beds, and consisting of poorly consolidated, tuffaceous material, granules of pink clay, zeolites, and manganese oxides. Other bedded deposits are replacements of limestone, sandstone, and conglomerate, and a fossil bog was noted.

The proximtity of volcanic rocks to the manganese-bearing areas, and the broader structural relations, suggest the possibility that the manganese was derived from volcanic rocks of the Sierra Maestra Mountains, transported by artesian waters, together with silica and deposited in the porous tuff strata and as masses of manganiferous jasper in joints and fissures in the limestone and glauconitic sandstone. The jasper and bedded tuff, in weathering, have contributed the manganese that is now found in the other rocks and in detrital deposits.

D. F. HEWETT: *Summary.*—Most manganese deposits offer two rather distinct problems: (1) that which is concerned with the features, source, manner of deposition, and distribution of certain primary minerals, only a few of which are useful in the arts, and (2) that which is concerned with the features, source, manner of deposition, and distribution of certain secondary oxide minerals which are derived from the primary minerals and are highly useful.

Recent work shows, although the common primary manganese minerals, such as carbonates, silicates, and sulphides are widely found in deposits that are associated with igneous intrusions, there are a number of poorly defined manganiferous carbonates and silicates that are laid down with sediments. In some places these minerals form concretions in the sediments but elsewhere they appear to be uniformly distributed in thin zones.

Although the higher oxides and hydrous oxides of manganese appear to be deposited in the belt of weathering only, the lower oxides are apparently deposited under conditions found below the belt of weathering, or may be formed when the higher oxides are affected by regional metamorphism.

Large bodies of the higher oxides and hydrous oxides of manganese, accumulate near localized bodies of carbonates and silicates when these are thoroughly weathered. In several regions, however, the occurrence of many manganese oxide deposits on the remnants of old erosion surfaces where the nearby sedimentary rocks are deeply weathered and the sources of the manganese are consequently obscure, indicates that under conditions of peneplanation there is an opportunity to accommodate in small areas the manganese that was formerly widely disseminated through the rocks.

R. W. STONE, *Secretary.*

SCIENTIFIC NOTES AND NEWS

INTERNATIONAL SCIENTIFIC ORGANIZATIONS

A meeting to organize an International Research Council is being held at Brussels beginning July 18, 1919. Delegates will be present from the National Research Council of this country, and from similar organizations in the various countries which have been associated with the United States during the recent war. The question of the admission of neutral countries will be brought before the meeting. Countries which have not organized a research council will be represented by delegates from their national academies.

The delegates from the United States of America are: W. W. CAMPBELL, *Chairman*, Chairman of American Delegation, International Astronomical Union; H. M. HOWE, Scientific Attaché at Paris, also representing Engineering; C. E. MENDENHALL, Scientific Attaché at London, also representing Physics; H. S. WASHINGTON, Scientific Attaché at Rome, also representing Geology; WM. BOWIE, Chairman of American Delegation, International Geophysical Union; E. W. WASHBURN, Chairman of American Delegation, International Chemical Union; W. S. THAYER, representing Medicine; JOHN C. PENNY, representing Patents; D. W. JOHNSON, representing Geography; H. F. MOORE, representing Biology and Fisheries.

A meeting to organize an International Chemical Union was held in London on July 15. The American delegates to this meeting were: E. W. WASHBURN, *Chairman*; EDWARD BARTOW, F. G. COTTRELL, CHAS. L. PARSONS, JULIUS STIEGLITZ, H. S. WASHINGTON; Alternates: A. B. LAMB and JAS. F. NORRIS.

An International Astronomical Union and an International Geophysical Union will be organized during the meeting at Brussels. It is planned to have these organizations take over the various international astronomical and geodetic committees which were in existence before the outbreak of the European war. Meetings of the American sections of these two unions were held at the National Research Council in Washington on June 23–25, at which the following delegates were selected: *Astronomical Union*, W. W. CAMPBELL, *Chairman*; W. S. ADAMS, S. I. BAILEY, BENJAMIN BOSS, W. S. EICHELBERGER, PHILIP FOX, W. J. HUMPHREYS, S. A. MITCHELL, F. R. MOULTON, H. N. RUSSELL, FRANK SCHLESINGER, C. E. ST. JOHN, F. H. SEARES, JOEL STEBBINS; *Geophysical Union*, WM. BOWIE, *Chairman*; L. A. BAUER, H. C. GRAVES, A. O. LEUSCHNER, G. W. LITTLEHALES, C. F. MARVIN, H. F. REID, EDWARD SIMPSON, J. T. WATKINS; Alternates: W. J. HUMPHREYS, J. F. HAYFORD, W. J. PETERS.

The provisional officers of the American sections of these two unions are as follows: Astronomical Union, W. W. CAMPBELL, *Chairman*; JOEL STEBBINS, *Secretary*; Geophysical Union, WILLIAM BOWIE, *Chairman;* H. O. WOOD, *Secretary*.

Conferences on the question of forming international organizations in

medicine, mathematics, geology, geography, biology, fisheries, and patents will be held in connection with the Brussels meetings.

The plan of voting suggested for the international council and the international unions is: One vote for nations having a population of less than five million, one vote additional for each additional five million of population or fraction thereof, except that nations having over twenty million have five votes only. The colonies of Great Britain will probably vote as separate nations.

THE TARIFF ON SCIENTIFIC SUPPLIES

Hearings were held on the three bills concerned with the tariff on chemical and optical glassware and scientific apparatus (H. R. 3734, 3735, and 4386) before the Committee on Ways and Means of the House of Representatives on June 11–13, 1919. Representative J. W. FORDNEY, of Michigan, Chairman of the Committee, presided. Among those who testified at the hearing were: representatives of the glass workers' unions; representatives of the manufacturers of chemical glassware, chemical porcelain, optical instruments, and scientific apparatus in general; and Dr. CHARLES H. HERTY, Editor of the Journal of Industrial and Engineering Chemistry, Dr. W. F. HILLEBRAND, of the Bureau of Standards, Mr. H. E. HOWE, of the National Research Council, Dr. CHARLES L. PARSONS, Secretary of the American Chemical Society, Lieut. Col. M. A. REASONER, of the Field Medical Supply Depot, U. S. A., Col. J. K. RUTHERFORD, Ordnance Dept., U. S. A., and Mr. F. J. SHERIDAN, of the U. S. Tariff Commission. Practically all the evidence was in favor of the removal of the duty-free importation privilege, and the imposition of whatever tariffs might be necessary to insure the establishment of the scientific apparatus and chemical glassware industries in the United States.

As these bills are of direct interest to all scientists and scientific institutions, the essential paragraphs of the bills are reproduced below:

H. R. 3734. (Introduced by Mr. BACHARACH, of New Jersey, on May 28, 1919.) A Bill to provide revenue for the Government and to establish and maintain the manufacture of optical glassware in the United States. Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That on and after the day following the passage of this act, there shall be levied, collected, and paid upon the articles named herein when imported from any foreign country into the United States or any of its possessions, except the Philippine Islands and the islands of Guam and Tutuila, the rates of duties which are herein prescribed, namely: Glass plates or disks, rough cut or unwrought, for use in the manufacture of optical instruments, spectacles, and eyeglasses, suitable only for such use, as covered by paragraph 494 of the Tariff Act of October 3, 1913, 45 per centum ad valorem. And such articles and all scientific instruments in which such articles as enumerated in said paragraph 494 are used, shall not be entitled to free entry under paragraph 573 of the above mentioned act.

H. R. 3735. (Introduced by Mr. BACHARACH on May 28, 1919.) A Bill to provide revenue for the Government and to establish and maintain the manufacture of chemical glassware in the United States. Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That on and after the day following the passage of this act there shall be levied, collected, and paid upon the articles named herein when imported from any foreign country into the United States or any of its possessions, except the Philippine Islands and the islands of Guam and Tutuila, the rates of duties herein prescribed, namely: Glasswares and porcelain wares used in the sciences, and in laboratories, or selected for laboratories of chemistry, physics, bacteriology, and biology, in their application to education, the industries, medicine, and the public health, including equipment for metallurgy, mineralogy, and testing of materials, and other similar uses, as covered by paragraphs 80 and 84 of the Tariff Act of October 3, 1913, 60 per centum ad valorem. And such articles shall not be entitled to free entry under paragraph 573 of the above-mentioned act.

H. R. 4386. (Introduced by Mr. MOTT on June 2, 1919.) A Bill to provide revenue for the Government and to establish and maintain the manufacture of philosophical, scientific, and laboratory apparatus in the United States. Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That on and after the day following the passage of this act there shall be levied, collected, and paid upon the articles named herein, when imported from any foreign country into the United States or any of its possessions, except the Philippine Islands and the islands of Guam and Tutuila, the rates of duties which are herein prescribed, namely: Philosophical, scientific, and laboratory apparatus, utensils, and instruments, and parts thereof, finished or unfinished, 60 per centum ad valorem.

UNION OF SCIENTIFIC AND TECHNICAL WORKERS

The following resolution was adopted by the convention of the American Federation of Labor, held at Atlantic City during the week of June 16–21. The resolution was initiated by the (District of Columbia) Union of Federal Employees, with which the scientific and technical workers are now affiliated,[1] and was introduced into the convention jointly by the National Federation of Federal Employees and the American Federation of Teachers.

WHEREAS, Scientific research and the technical application of results of research form a fundamental basis upon which the development of our industries, manufacturing, agriculture, mining, and others must rest; and

WHEREAS, The productivity of industry is greatly increased by the technical application of the results of scientific research in physics, chemistry, biology and geology, in engineering and agriculture, and in

[1] See this JOURNAL 9: 303. May 19, 1919.

the related sciences; and the health and well-being not only of the workers but of the whole population as well, are dependent upon advances in medicine and sanitation, so that the value of scientific advancement to the welfare of the nation is many times greater than the cost of the necessary research; and

WHEREAS, The increased productivity of industry resulting from scientific research is a most potent factor in the ever-increasing struggle of the workers to raise their standards of living, and the importance of this factor must steadily increase since there is a limit beyond which the average standard of living of the whole population cannot progress by the usual methods of readjustment, which limit can only be raised by research and the utilization of the results of research in industry; and

WHEREAS, There are numerous important and pressing problems of administration and regulation now faced by federal, state, and local governments, the wise solution of which depends upon scientific and technical research; and

WHEREAS, The war has brought home to all the nations engaged in it the overwhelming importance of science and technology to national welfare, whether in war or in peace, and not only is private initiative attempting to organize far-reaching research in these fields on a national scale, but in several countries governmental participation and support of such undertakings are already active; therefore be it

RESOLVED, By the American Federation of Labor in convention assembled, that a broad program of scientific and technical research is of major importance to the national welfare and should be fostered in every way by the Federal Government, and that the activities of the Government itself in such research should be adequately and generously supported in order that the work may be greatly strengthened and extended; and the Secretary of the Federation is instructed to transmit copies of this resolution to the President of the United States, to the President *pro tempore* of the Senate, and to the Speaker of the House of Representatives.

NOTES

A "Fixed Nitrogen Research Laboratory" has been organized in the Nitrate Division of the Ordnance Department, with headquarters at the American University, in buildings formerly occupied by the Chemical Warfare Service. Lieut. Col. A. B. LAMB, of the Chemical Warfare Service, is director; Dr. R. C. TOLMAN, formerly of the Chemical Warfare Service, and Prof. W. C. BRAY, of the University of California, are associate directors; and Dr. H. A. CURTIS, formerly of the Nitrate Division, Ordnance Department, is executive officer. The work on the fixation of nitrogen carried on during the war in the Agricultural Department laboratories at Arlington, Virginia, the Geophysical Laboratory, and elsewhere, will be concentrated at the American University. In the absence of Col. Lamb in Europe, Dr. Tolman is acting director. At present the staff consists of fifty-five persons.

A series of deep-sea soundings off the southern Atlantic and Pacific coasts of the United States are provided for in the plans for all the Coast and Geodetic Survey steamers which are being sent this summer to the Pacific coast.

The offices of the National Research Council were removed on July 1 from 1023 Sixteenth Street to the building formerly occupied by the Navy League, at 1201 Sixteenth Street.

In the course of the survey of the Florida Reefs by the U. S. Coast and Geodetic steamer *Hydrographer* (C. H. Ober, commanding), an improved type of sounding tube has been tested during recent months in the deep waters of the Straits, with marked success.

Dr. Graham Edgar, formerly secretary of the Washington office of the Research Information Service, National Research Council, and lately with the Nitrate Division, has been appointed professor of chemistry at the University of Virginia.

Dr. W. S. Eichelberger, of the Naval Observatory, has been named as one of three American correspondents of the Bureau des Longitudes of France.

Mr. C. O. Ewing has resigned from the Bureau of Chemistry to accept the position of assistant chief chemist with the United Drug Company (Liggett-Rexall) at Boston, Massachusetts.

Dr. L. J. Gillespie, chemist in the Bureau of Plant Industry, has been appointed professor of physical chemistry in Syracuse University, Syracuse, New York. He will assume the new position about September 1, 1919.

Mr. William B. Heroy resigned from the Geological Survey on July 1, to accept a position on the editorial staff of the *Electrical World*, published by the McGraw-Hill Company, in New York City.

Mr. E. Lester Jones, chief of the Coast and Geodetic Survey, has been given the degree of Master of Arts by Princeton University.

Director Van H. Manning, of the Bureau of Mines, received the honorary degree of Doctor of Engineering from the University of Pittsburgh in June.

Dr. S. W. Stratton, director of the Bureau of Standards, was given the honorary degree of Doctor of Science by Yale University in June.

Major Clarence J. West, formerly of the Editorial Section, Chemical Warfare Service, will direct the newly-established Information Department of the laboratories of Arthur D. Little, Inc., Cambridge, Massachusetts.

Mr. R. R. Williams resigned from the Bureau of Chemistry, U. S. Department of Agriculture, in April and is now with the Melco Chemical Company, 52 Vanderbilt Avenue, New York City, manufacturers of isopropyl and other secondary alcohols and their derivatives, including acetone and various esters.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 9 AUGUST 19, 1919 No. 14

RADIOTELEGRAPHY.—*Calculation of antenna capacity.* L. W AUSTIN, U. S. Naval Radio Research Laboratory.

The theoretical predetermination of antenna capacity has always, until recently, been a matter of great uncertainty. Professor Howe[1] in 1914 published an article in the London Electrician giving methods for the calculation of capacities of elongated flat top antennas composed of parallel wires, and giving tables and curves making it possible easily to determine the capacities of small antennas of this type. In another article he later also gave formulas[2] for umbrella antennas.

In 1915 Doctor L Cohen published antenna capacity formulas in the Electrical World.[3] Very recently in Circular No. 74, the Bureau of Standards[4] gave formulas for elongated parallel wire antenna capacities which are in very fair agreement with observed values and also with the results of Professor Howe In all of these formulas, except where the results are given in curves and tables, the calculations are more or less laborious, and, of course, do not apply to antennas of other shapes than those mentioned

It was discovered empirically during the past year that the capacity of all antennas not too elongated in shape and having

[1] HOWE, G W O London Electrician 73: 829, 859, 906 1914

[2] Op cit 75: 870 1915

[3] COHEN, L Electrical World 65: 286 1915

[4] Bur Stand Cir 74: 239 1918

their wires not too widely spaced, can be very approximately represented by the formula

$$c = (4\sqrt{a} + 0.88\ a/h) \times 10^{-5} \qquad (1)$$

where c is the capacity, a the area, and h the mean height in microfarads and meters. For antennas having a length l more than eight times the breadth b, the above formula must be multiplied by an elongation factor, and we have

$$c = (4\sqrt{a} + 0.88\ a/h)\ (1 + 0.015\ l/b) \times 10^{-5} \qquad (2)$$

Equation (1), while derived empirically, is in reality the sum of the usual expressions for the capacity of a disk in space and that for a two plate condenser, disregarding edge effect. These equations can be depended upon to give results correct in general to 10 per cent for the antenna top, to which must be added the capacity of the downleads and that due to metal towers, etc. The poorest agreement is found in the case of umbrella antennas, where the amount of wire is often not sufficient to give full capacity.

The closeness of wire spacing required to give approximately full capacity, differs very much with antennas of different shapes and sizes, the required spacing being closer the smaller the antenna. For long parallel wire antennas, this may be calculated from the Bureau of Standards formula already mentioned. In the case of some of the larger antennas, remarkably few wires are required. For example, on a certain triangular antenna about 300 meters on a side, flat tops composed of five wires about one meter apart, strung around the sides of the triangle gave nearly 90 per cent of the capacity obtained when the whole triangular area was filled in. With parallel wire antennas of medium dimensions, a spacing of one meter will generally insure over 90 per cent of the possible capacity.

Table 1 gives some observed values of capacity for elongated parallel wire antennas, and a comparison of the capacities calculated according to the Bureau of Standards formula and equation (2). The data for calculation are given below table 1.

Table 2 gives observed values of capacity for antennas of various shapes compared with the values calculated according to equation (1).

TABLE 1

Elongated Parallel Wire Antennas—Capacity in Microfarads

Antenna Types	Observed	Leads Est'd	Observed minus leads	Calculated BS formula	Calculated Eq. (2)
1. Marconi "L".........	0.060	0.007	0.053	0.0542	0.0545
2. Medium Ship Type...	0.0020	0.0006	0.0014	0.00147	0.00151
3. Portable Ship Type...	0.00040	0.00006	0.00034	0.000335	0.000350
4. Model Marconi "L"...	...	...	0.00028	0.000275	0.000255

Data for Calculation

Length m	Breadth m	Number of wires n	Diam.[a] mm	Area m^2	Height m	l/b
1. 1830	160	32	10	$29.3 \cdot 10^4$	104	11.4
2. 91.5	9.15	11	3	$8.38 \cdot 10^2$	49	10
3. 25.9	1.52	6	3	39.4	12	17
4. 18.3	0.406	6	2.5	7.43	1.52	45

[a] Approximate wire diameter.

TABLE 2

Various Antenna Shapes—Capacity in Microfarads

Antenna Types	Observed	Leads Est'd	Observed minus leads	Calculated Eq. (1)	Area m^2	Height m
5. Triangle...........	0.0155	0.003	0.0125	0.0129	$5.98 \cdot 10^4$	170
6. Square.............	0.0180	0.003	0.0150	0.0136	$6.25 \cdot 10^4$	160
7. Irregular...........	0.038	0.002	0.0360	0.0378	$26.8 . 10^4$	137
8. Triangle...........	0.0065	0.001	0.0055	0.0054	$1.156\ 10^4$	91.5
9. Portable Triangle...	0.00084	0.00006	0.00078	0.00085	$2.67 \cdot 10^2$	12
10. Model Triangle.....	.....	.....	0.000075	0.000068	1.457	0.633
11. Model Circular Disk	.....	.....	0.000135	0.000125	3.56	0.635
12. Umbrella..........	0.016	0.0015	0.0145	0.0147	$7.24 \cdot 10^4$	162
13. Model Circular Disk	.....	.....	0.000053	0.000055	0.933	0.50

The chief uncertainty in the observed values of both tables lies in the estimation of the capacity of the downleads, etc. In the case of the models 4, 10, and 13, this was measured along with that due to the measuring instruments and subtracted from the observed values.

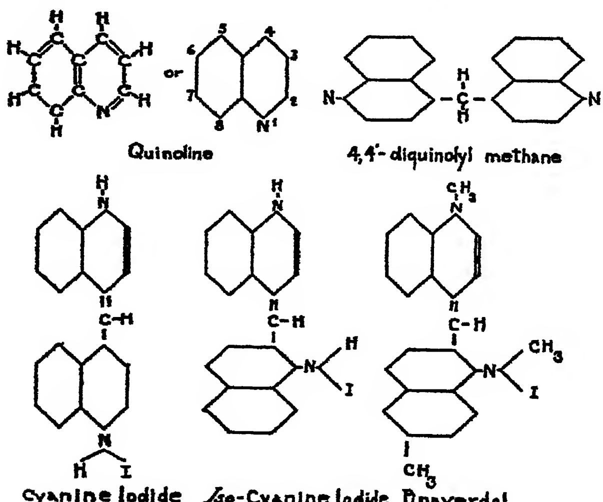
In addition to its importance in radiotelegraphy, equation (1) has a more purely scientific interest, since it appears to represent the capacity of plate condensers in general for all values of plate separation provided one of the plates is grounded. The so-called edge effect is represented by the capacity in space term. The expression if exact for circular plates, should be nearly so for all

not too elongated forms. Experiments are now being carried on to verify these relations and the preliminary results indicate the correctness of the equation for all ratios of R/d. This part of the work will be published separately in the near future.

CRYSTALLOGRAPHY.—*The crystallography and optical properties of the photographic sensitizing dye, pinaverdol.* EDGAR T. WHERRY and ELLIOT Q. ADAMS, Bureau of Chemistry.

CHEMISTRY

Pinaverdol is the trade name of a synthetic dyestuff[1] related to quinoline, and used to sensitize the silver halide[2] of photographic plates to green and yellow light. Its structure is indicated by the name "1,1',6'-trimethyl-*iso*-cyanine iodide." "Cyanine iodide" is a tautomeric form of the hydriodide of 4,4'-diquinolyl



[1] A full description of the preparation and properties of this substance will appear in the Journal of Industrial and Engineering Chemistry.

[2] "Halide" is a general term comprising chloride, bromide, and iodide, *i. e.*, binary salts derived from any of the halogens.

methane, and the isomeric "*iso*-cyanine iodide" is the corresponding form of the hydriodide of 4,2′-diquinolyl methane—that is, it differs from cyanine iodide in that the second (or primed) quinoline nucleus is attached at the carbon atom adjacent to the nitrogen, instead of at the one diametrically opposite.

Prior to 1914 this dyestuff was made only in Germany, but is now being produced both in England and the United States. The present paper consists of a detailed description of the crystallography and optical properties worked out for the purpose of testing the identity of these several preparations.

CRYSTALLOGRAPHY

The crystals from different preparations of pinaverdol exhibit considerable variation in habit, ranging from markedly prismatic to thinly tabular. Orientation of the different types is made easy, however, by the brilliant and striking reflection-pleochroism present. There are two prominent zones of faces, lying at right angles to one another, and all of the forms in one of them reflect brass-yellow light, while the dominant forms in the other yield beetle-green reflections. The former zone has been taken as the prismatic one, and the latter held right and left. The crystal system then proves to be monoclinic, although since the base lies but 1° 40′ away from the pole of the prism zone, and the plus and minus orthodomes are often about equally developed, it is decidedly close to the rhombic system. According to current usage, it would perhaps be described as "pseudo-rhombic," but it seems to the writers desirable to use prefixes which express more definitely the true relationships.[3] In accordance with the plan we have proposed, pinaverdol would be described as "lepto-monoclinic, but peri-rhombic." It may also be noted that according to Fedorov's usage, since the prism angle is 84° 30′, that is, nearer 90° than 60°, this substance would be classed as hypo-tetragonal or tetragonoidal.

About 20 crystals of all habits were measured on the Gold-

[3] Journ. Wash. Acad. Sci. 9: 153. 1919.

schmidt two-circle goniometer. Some of them proved to be very rich in forms, although the majority of these are extremely minute, and would have been very difficult indeed to locate on any other instrument. The coordinate angles of the 41 forms observed are listed in table 1; not quite all of them were ob-

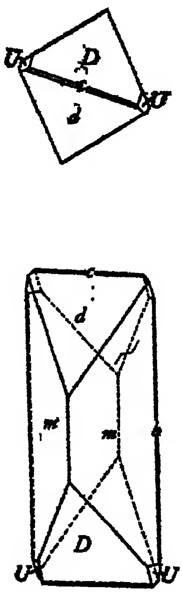


Fig. 1.

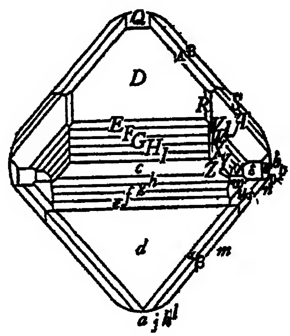


Fig. 2.

Crystals of pinaverdol: Fig. 1 typical habit. Fig. 2 shows all forms observed.

served on any single crystal, but all were obtained on a sufficient number of crystals to regard them as thoroughly established. The probable error of measurement in the case of the larger forms is ± 5′.

Typical combinations of these forms are shown in figures 1–4. Figure 1 represents in orthographic and clinographic projections, or plan and perspective, the typical habit of the bulk of the crystals. The unit prism *m* (110) is the dominant form, with narrow faces of the clinopinacoid *b* (010) in its zone. At rigth angles to this zone lies that of the orthodomes, which are ap-

TABLE 1

ANGLE TABLE FOR PINAVERDOL

System monoclinic; lepto-monoclinic, peri-rhombic $a : b : c = 1.1014 : 1 : 1.6053$; $\mu (= 180 - \beta) = 88° 20'$

Number letter	Symbols Gdt.	Symbols Mill	Times noted	Description	Observed ±5′ φ	Observed ±5′ ρ	Calculated φ	Calculated ρ
1 *c*	0	001	8	Narrow, curved	90° 00′	1° 40′	90° 00′	1° 40′
2 *b*	0∞	010	30	Narrow	0° 00′	90° 00′	0° 00′	90° 00′
3 *a*	∞0	100	12	Very narrow, curved	90° 00′	90° 00′	90° 00′	90° 00′
4 *j*	4∞	410	24	Very narrow, curved	75° ..	90° 00′	74° 37′	90° 00′
5 *k*	3∞	310	12	Very narrow, curved	70° ..	90° 00′	69° 51′	90° 00′
6 *l*	2∞	210	12	Very narrow, curved	61° ..	90° 00′	61° 10′	90° 00′
7 *m*	∞	110	75	Dominant prism form	42° 15′	90° 00′	42° 15′	90° 00′
8 *n*	∞2	120	16	Very narrow, curved	24° ..	90° 00′	24° 26′	90° 00′
9 *o*	∞3	130	36	Very narrow, curved	17° ..	90° 00′	16° 51′	90° 00′
10 *p*	∞4	140	32	Very narrow, curved	12° ..	90° 00′	12° 48′	90° 00′
11 *ε*	0$^1/_2$	012	4	Part of curve	2° ..	38° ..	2° 04′	38° 46′
12 *δ*	01	011	12	Small, often curved	1° ..	58° ..	1° 02′	58° 05′
13 *γ*	02	021	6	Part of curve	0° ..	72° ..	0° 31′	72° 42′
14 *d*	10	101	16	Well developed	90° 00′	56° 05′	90° 00′	56° 05′
15 *e*	$^2/_3$0	203	3	Very narrow, curved	90° 00′	45° ..	90° 00′	45° 02′
16 *f*	$^1/_2$0	102	6	Very narrow, curved	90° 00′	37° ..	90° 00′	37° 10′
17 *g*	$^1/_3$0	103	3	Very narrow, curved	90° 00′	27° ..	90° 00′	27° 15′
18 *h*	$^1/_4$0	104	2	Very narrow, curved	90° 00′	21° ..	90° 00′	21° 29′
19 *I*	—$^1/_6$0	$\bar{1}06$	5	Part of curve	90° 00′	12° ..	90° 00′	12° 04′
20 *H*	—$^1/_4$0	$\bar{1}04$	3	Very narrow, curved	90° 00′	19° ..	90° 00′	18° 33′
21 *G*	—$^1/_3$0	$\bar{1}03$	5	Very narrow, curved	90° 00′	25° ..	90° 00′	24° 33′
22 *F*	—$^1/_2$0	$\bar{1}02$	3	Very narrow, curved	90° 00′	35° ..	90° 00′	34° 59′
23 *E*	—$^2/_3$0	$\bar{2}03$	3	Very narrow, curved	90° 00′	43° ..	90° 00′	43° 19′
24 *D*	—10	$\bar{1}01$	18	Dominant dome form	90° 00′	55° 00′	90° 00′	55° 01′
25 *Q*	—20	$\bar{2}01$	2	Part of curve	90° 00′	70° ..	90° 00′	70° 54′
26 *w*	$^1/_2$	112	2	Part of curve	43° ..	48° ..	43° 22′	47° 50′
27 *u*	1	111	8	Part of curve	43° ..	65° ..	42° 49′	65° 26′
28 *s*	2	221	4	Part of curve	43° ..	77° ..	42° 32′	77° 04′
29 *S*	—2	$\bar{2}21$	4	Part of curve	42° ..	77° ..	41° 58′	76° 58′
30 *T*	—$^3/_2$	$\bar{3}32$	8	Part of curve	42° ..	73° ..	41° 52′	72° 49′
31 *U*	—1	$\bar{1}11$	12	Dominant pyramid	41° 45′	65° 05′	41° 41′	65° 03′
32 *V*	—$^2/_3$	$\bar{2}23$	4	Very narrow, curved	41° ..	55° ..	41° 23′	54° 58′
33 *W*	—$^1/_2$	$\bar{1}12$	6	Very narrow, curved	41° ..	47° ..	41° 06′	46° 48′
34 *X*	—$^1/_3$	$\bar{1}13$	6	Very narrow, curved	41° ..	35° ..	40° 29′	35° 08′
35 *Y*	—$^1/_4$	$\bar{1}14$	6	Very narrow, curved	41° ..	28° ..	39° 53′	27° 37′
36 *Z*	—$^1/_6$	$\bar{1}16$	6	Very narrow, curved	40° ..	19° ..	38° 39′	18° 54′
37 *R*	—1$^1/_2$	$\bar{2}12$	4	Very narrow, curved	60° ..	60° ..	60° 41′	58° 37′
38 *α*	21	211	30	Narrow, curved	61° ..	73° ..	61° 25′	73° 24′
39 *β*	32	321	20	Narrow, curved	54° ..	80° ..	53° 54′	79° 38′
40 A	—21	$\bar{2}11$	36	Narrow, but bright	61° ..	73° ..	60° 56′	73° 09′
41 B	—32	$\bar{3}21$	30	Narrow, curved	54° ..	80° ..	53° 32′	79° 31′

proximately equally developed, *d* (101) and *D* ($\bar{1}01$). In the zone of these domes there are also narrow faces of the base *c* (001). Finally, small faces of the minus unit pyramid *U* ($\bar{1}11$), are usually present.

Using the upper, orthographic projection of fig. 1 as a basis, figure 2 has been drawn to show the positions which are occupied by all of the forms observed. Many of these have had to be made

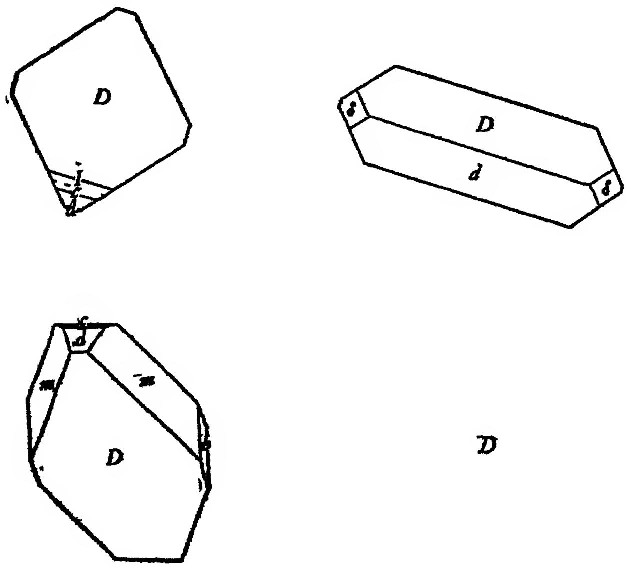


Fig. 3. Fig. 4.

Pinaverdol crystals. Habits shown by material of English and German origin.

relatively much wider than they are in the actual crystals to show them at all. For lettering these forms the plan has been followed of assigning the usual letters, *a*, *b*, *c*, *d*, and *m* to the simple forms, and then in any one zone following as far as possible an alphabetical sequence. Thus the several prisms are made successively *j*, *k*, *l*, *m*, *n*, *o*, and *p*, the plus orthodomes *d*, *e*, *f*, *g*, and *h*, the plus unit *s*, *u* (111), and *w*, the plus orthopyramids α and β, and the clinodomes α, δ, and ϵ. The minus forms are then named by capital letters corresponding to the small ones of the plus forms. This gives *D*, *E*, *F*, *G*, *H*, and *I* for the ortho-

domes, *S*, *T*, *U*, *V*, *W*, *X*, *Y*, and *Z*, for the unit pyramids, and A and B, regarded as Greek capitals, for two of the orthopyramids; and finally, two letters left over, *Q* and *R*, are applied to a steep orthodome and the remaining orthopyramid, respectively.

A habit rather frequently assumed, especially by material received from England, is shown in plan and perspective in figure 3. Its peculiar tabular aspect is due to the prominent development of the minus orthodome *D* ($\bar{1}01$). The prism *m* (110) is usually present around the edge of the plates, although these sometimes become so thin that the prism is practically crowded off. The clinopinacoid, *b* (010), is often better developed on crystals of this habit than in those of type 1, and a small plus orthodome, *d* (101), is also usually present as a bounding form. Instead of a plane face where the base, *c* (001), should lie, a curved surface is usually present, which extends from about the position of *c* back as far as that of the minus orthodome *I* ($\bar{1}06$).

Still another distinct habit is illustrated in figure 4. This appears most frequently in a preparation obtained from Germany before the war, which was crystallized from an unknown solvent. In this there is marked elongation along axis *b*, making the crystals pseudo-prismatic on the orthodomes *d* (101) and *D* ($\bar{1}01$). The only other unusual feature shown by these crystals is the rather prominent development of the clinodome δ (011).

COLOR PHENOMENA

As noted in the introductory paragraph under the heading Crystallography, the crystals of pinaverdol exhibit a striking and brilliant reflection pleochroism. This phenomenon being a rather uncommon one, it will now be described in greater detail.

In any biaxial crystal there are three directions at right angles to each other in which properties connected with light are exhibited. In the rhombic system these directions coincide with the crystallographic axes; in the monoclinic, one coincides with axis *b*, while the other two are limited to the plane of symmetry, but do not in general coincide with either of the crystallographic axes lying in that plane. In the present instance, however, the properties of the crystals are peri-rhombic, as we have termed it,

that is, very close to rhombic in character, so marked deviation of the optical directions from axes *a* and *c* is not to be expected. For practical purposes, therefore, the optical phenomena may be considered in the general direction of the three crystallographic axes.

The faces of the clinopinacoid *b* (100) reflect light of brilliant brass-yellow color. Those of the orthopinacoid *a* (100) have not been observed broad enough to determine the color accurately but it does not appear to be materially different from that of *b*; on theoretical grounds, of course, it must be at least slightly different. The prism faces *m* (110), which lie about midway between these two pinacoids, are correspondingly also brass-yellow.

Faces lying perpendicular to axis *c*, or nearly so, show a deep bronze-violet reflection color. Intermediate colors are of course shown by all forms lying between the base and the prism, namely, by the domes and pyramids, and the actual color is a brilliant metallic green, which may perhaps best be described as beetle-green. The nearer one of these forms lies to the base, the darker the green, and the nearer the prism, the more yellow appears in it. In fact, the colors of a form may be correlated directly with the value of its coordinate angle ρ, which represents the angle between the zone axis of the prism and the perpendicular to the face in question. For forms of sufficient size to permit the certain recognition of their color, the relations are as follows:

TABLE 2

Colors of Crystals

Letter symbol	ρ angle	Color
c (001)	1° 40′	Violet
I ($\bar{1}$06)	12° 04′	Violet
ϵ (012)	38° 46′	Dull brownish green
D ($\bar{1}$01)	55° 01′	Bright green
d (101)	56° 05′	Yellow-green
δ (011)	58° 05′	Yellow-green
U ($\bar{1}$11)	65° 03′	Green-yellow
A ($\bar{2}$11)	73° 09′	Green-yellow
m (110)	90° 00′	Yellow
b (010)	90° 00′	Yellow

It is noteworthy that in every case the pseudo-faces which have developed on pinaverdol crystals through contact with the glass container show similar colors, corresponding to their position. A most striking effect is obtained when a sheet, made up of crystals lying in all sorts of positions, is removed from against a glass surface and examined in reflected light, especially with the aid of a low-power lens. Some of the grains are violet, some yellow, while the bulk of them are of different hues of green, the whole effect being kaleidoscopic in character.

When viewed through a nicol prism two components can be recognized in the light reflected from each face. The brassy prism zone faces yield for the two opposed directions of the vibration plane of the nicol, a yellow (plane parallel to *c*) and a violet (plane parallel to *a*) component; the green dome faces green (parallel to *c*) and violet (*a*); terminal forms show violet, which changes but slightly as the nicol is revolved.

A similar pleochroism of reflected light has been observed in but few substances. The best known case is magnesium platinocyanide, which has been described at length by Walter.[4] A dye known as diamond green or brilliant green, made by the Badische works, was stated by the same author to show it also, although no samples at our disposal do so. The mineral covellite, CuS, gives a metallic blue reflection color on the base, and Merwin[5] states that the color varies noticeably in different crystallographic directions. Goethite, FeOOH or $Fe_2O_3.H_2O$ yields nonmetallic reflection from most of its faces, but one pyramid is reported by Goldschmidt and Parsons[6] as giving a yellow colored signal.

OPTICAL PROPERTIES

Since pinaverdol is readily soluble in organic solvents, it is necessary to use for its study by the immersion method under the microscope aqueous liquids of known refractive indices, and solutions of potassium-mercuric iodide and barium-mercuric

[4] WALTER, B. *Die Oberflächen oder Schillerfarben.* Braunschweig, 1895.

[5] MERWIN, H. E. This JOURNAL 5: 341. 1915.

[6] GOLDSCHMIDT, VICTOR, and PARSONS, A. L. Amer. Journ. Sci. 29: 235. 1910.

iodide in diluted glycerol were found to be satisfactory. Crystals greater than 0.02 mm. in diameter are practically opaque for ordinary white light, but by dissolving a little of the substance in hot methyl alcohol and allowing the liquid to cool rapidly, minute needles of satisfactory transparency can be obtained. For red light, which may be obtained by the use of a Wratten E-red No. 23 ray-filter, the transmission of light is much better. The following optical properties could be observed:

In ordinary light: Crystals, rods with oblique or square terminations, breaking into irregular fragments. Color very intense, with pleochroism from violet-brown to brown to deep greenish brown; or, in very thin crystals violet to brown to yellow-brown. By the use of a monochromatic illuminator, the crystals showing violet-brown color were found to transmit the red end of the spectrum from the limit of visibility to the orange of wave length about 600; on decreasing the wave length, marked absorption was exhibited, the crystals being highly opaque for the yellow, green, and part of the blue; but on reaching the middle blue at about wave-length 470 transmission was again noted, and continued to the end of the visible violet. The directions in the crystals giving brown or greenish brown behaved differently, however, the red end of the spectrum being absorbed, while a slight though distinct transmission appeared in the yellow and green, with absorption in the blue and violet.

Refractive indices: There is such a tendency to yield metallic reflections on the part of the pinaverdol crystals that refractive index determinations do not yield very satisfactory results. The lowest index α, which is shown lengthwise of the crystals of the usual prismatic habit, is about 1.58, for light of wave length 625; this is the direction in which the transmission is usually greatest, and the color violet. The other two indices are much greater than 1.75, which is that of the highest liquid which it has been found possible to prepare. They probably reach a value of at least 2.00. The greenish brown and yellowish brown colors correspond to these, the absorption being great in both of them.

In parallel polarized light, nicols crossed: The extinction is

inclined on crystals turned so that axis b is more or less vertical, and reaches a maximum of $5° \pm 1°$. The double refraction is excessively strong, so that no color effects are obtained. The sign of elongation is negative.

In convergent polarized light: Traces of biaxial figures are sometimes seen, but little can be determined about them. The plane of the optic axes runs lengthwise; the sign is clearly negative; and the optical orientation is $X \wedge c = 5°$ in acute angle β, but whether Y or Z = b is uncertain.

These properties, with but minor variations, are shown by several different preparations made in this laboratory, by a German product obtained before the war, and by the English "sensitol green." The identity of all of the substances is thus established.

ORNITHOLOGY.—*Grandalidae, a new family of turdine Passeriformes.* HARRY C. OBERHOLSER, Biological Survey.

The genus *Grandala* was based by Hodgson on a unique new species which had been obtained in Nepal and which was named by him *Grandala coelicolor.*[1] This beautiful and otherwise remarkable bird has hitherto been referred to the Turdidae, usually without question. It has commonly been considered most closely allied to *Sialia* Swainson, and, indeed, by Seebohm[2] was even made a subgenus of that group. It was evidently so placed because of its booted tarsi, blue color, and general size, for in no other important respect does it suggest *Sialia.* Even a casual examination is sufficient to show that *Grandala* has, as Oates long ago concluded,[3] nothing to do with *Sialia.* In fact it does not belong in the same family, nor, indeed, to any other currently recognized family of passeriform birds, and it forms, consequently, a very distinct monotypic group, which should stand as

Grandalidae, fam. nov.

Diagnosis: Similar to the *Turdidae*, but bill motacilline, not turdine, slender; tip of maxilla not hooked; basal portion of culmen straight or

[1] Journ. Asiatic Soc. Bengal 12: 447. June, 1843.
[2] Cat. Birds Brit. Mus. 5: 328. 1881.
[3] Fauna Brit. Ind., Birds 2: 110. 1890.

even slightly concave, with only the tip noticeably decurved (instead of being convex and more or less decurved from base); gonys short, not longer than the exposed portion of the mandibular rami (instead of longer, as in the *Turdidae*), posteriorly not reaching to the anterior end of the nostrils, and not ascending, but, with the mandibular rami, forming a straight line; nostrils entirely exposed; wings very long and pointed, when closed reaching nearly to the end of the tail; secondaries relatively very short, much as in the *Hirundinidae*, their tips falling short of the tip of the longest primary by nearly one-half of the total length of the closed wing (instead of less than one-third in the *Turdidae*); second primary, counting from the outermost, usually longest but always at least equal to the third.

General characters: Bill rather short (about one-half the length of the head), slender, somewhat depressed basally, but somewhat compressed distally, in general aspect motacilline rather than turdine, its lateral outline nearly straight, the culmen straight or slightly concave, near its tip noticeably decurved; tip of maxilla not hooked; gonys short, not longer than the exposed portion of mandibular rami, and posteriorly not reaching to the anterior end of the nostrils, not ascending but continuing in a straight line from the mandibular rami; terminal portion of maxillar tomium slightly notched; nostrils fusiform or lengthened elliptical, entirely exposed, the feathers of the forehead reaching to their posterior end; narial and rictal bristles short and weak; wings very long and pointed, when closed reaching nearly to the end of the tail; wing tip long, the secondaries relatively very short, the tip of the longest primary exceeding them by nearly one-half (more than two-fifths) of the total length of the closed wing; tertials short, about the length of the longest secondaries; first (outermost) primary very short, about 15 mm. in length; second primary usually longest; third primary equal to the second or slightly shorter; fourth primary decidedly shorter than the third; and all the others regularly decreasing in length; none of the primaries sinuated on their inner webs, but the third and fourth primaries distinctly sinuated on their outer webs, and the fifth slightly so; tail of 12 feathers, about three-fifths of the length of the wing, deeply emarginate, the feathers moderately broad and stiff, their ends obtusely pointed; upper tail-coverts rather long; tarsi moderately long and slender, their length about $2^1/_5$ times the length of the exposed culmen; acrotarsium entire; toes moderately long and slender; claws of moderate length and curvature; claw of hallux not lengthened; length of middle toe without claw three-fifths of the length of the tarsus; plumage of male more or less metallic; coloration of sexes different; and young streaked.

Type genus: Grandala Hodgson.

Remarks: It is rather surprising that the genus *Grandala* has not before been taken out of the *Turdidae*, since its aberrance is so apparent. In only two important characters—its booted tarsi and streaked young

—does it resemble the *Turdidae*. It is, so far as we recall, the only passerine bird, excepting members of the *Hirundinidae*, that has such a remarkably long wing tip, which is produced by its relatively short secondaries. By this and its other external proportions, it is one of the most distinctively characterized of the families of *Passeriformes*. In some respects, particularly those of its bill and booted tarsus, it recalls some of the *Sylviidae*, and also some of the *Brachypterygidae*, as Oates has already suggested,[4] but from the latter family it differs in its relatively short gonys (compared with the length of the exposed part of the mandibular rami), less turdine shape of the bill, relatively short tarsi, long second and third primaries (beginning from the outermost) relatively short first primary, long wings, and long wing tip. It is, moreover, probably more nearly related to the *Turdidae* than to the *Brachypterygidae*, though not closely to either. Nor is it in any sense intermediate, since it differs in many of the same respects from both these families. It might be considered a highly specialized offshoot from the turdine stem, although the determination of its exact affinities must await the examination of its anatomy, which we confidently predict will serve to emphasize still more strongly its external peculiarities.

The only species in this new family is *Grandala coelicolor* Hodgson.

[4] Fauna Brit. Ind., Birds 2: 110. 1890.

chiefly in its smaller size and decidedly darker mantle. The range of *Larus hyperboreus hyperboreus* extends over northern Asia, most of Europe, and northeastern North America, while *Larus hyperboreus barrovianus* occurs in western North America. H. C. O.

ORNITHOLOGY.—*Food habits of the mallard ducks of the United States.* W. L. McATEE. U. S. Dept. Agr. Bull. **720**: 1–36. 1918.

This bulletin contains the results of investigations on the food and food habits of *Anas platyrhyncha*, *Anas rubripes*, and *Anas fulvigula*, three closely allied and important game birds of the United States. Of *Anas platyrhyncha*, which has furnished most of the breeds of domestic ducks, examination of 1725 stomachs, taken at all seasons in 22 states of the United States and in 2 Canadian provinces, formed the basis of the author's conclusions. The vegetable elements comprise nine-tenths of the food of this species, and consist principally of sedges, grasses, smartweeds, pondweeds, duckweeds, coontail, wild celery, and various other water plants. Of some, such as *Zizania aquatica*, chiefly the seeds are eaten, but of many others also the stems, leaves, root-stocks, buds, and tubers are used. Other miscellaneous vegetable items, such as seeds of trees like *Planera aquatica* and of shrubs like *Celtis*, together with some acorns, are taken. The animal food of the mallard, which is only about one-tenth of the whole, is made up chiefly of insects and mollusks.

An interesting fact in connection with the stomach examinations of this species is the large number of individual items which sometimes are present. In a single stomach taken in Louisiana there were found 75,200 seeds of various water plants, and in another taken in the same State, 102,400 seeds of *Jussiaea leptocarpa*.

Of *Anas rubripes*, including its subspecies *Anas rubripes tristis*, 622 stomachs were examined, chiefly from the United States. In these the vegetable food made up 76 per cent of the contents, and consisted chiefly of pond-weeds, grasses, sedges, and smartweeds, together with many other less important items. The animal food, which was 24 per cent of the whole, was mostly mollusks, crustaceans, and insects.

The Florida duck, *Anas fulvigula*, including its subspecies *Anas fulvigula maculosa*, lives on vegetable food, mostly grasses, smartweeds, sedges, water lilies, pondweeds, and other water plants, to the extent of 60 per cent of its total food; and on animal diet, mostly mollusks, insects, and crustaceans, to the extent of 40 per cent.

Two long tables at the end of this bulletin show the items of vegetable food identified in the stomachs of all three species examined, and the number of stomachs in which each item was found. H. C. O.

ORNITHOLOGY.—*On the anatomy of* Nyctibius *with notes on allied birds.* ALEXANDER WETMORE. Proc. U. S. Nat. Mus. **54**: 577–586. 1918.

An examination of the trunk and visceral anatomy of *Nyctibius griseus abbotti* furnishes some interesting results. It confirms Mr. Ridgway's suborder *Nycticoraciae*, to include the superfamilies *Caprimulgi*, *Podargi*, and *Steatornithes*.

Owing, however, to the close relationship of the *Podargi* and *Caprimulgi*, they are here regarded as best included in a single superfamily, so that the suborder *Nycticoraciae* as here outlined would be divided into two superfamilies, the *Steatornithoideae*, containing a single genus *Steatornis*, and the *Caprimulgoideae*, containing the families *Podargidae*, *Nyctibiidae*, *Aegothelidae*, and *Caprimulgidae*.

Among other things, attention might be called particularly to the forms of the tongues in this suborder, as there are four general types representative of the *Podargidae*, *Nyctibiidae*, *Steatornithidae*, and *Caprimulgidae*. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Description of a new Iole from the Anamba Islands.* HARRY C. OBERHOLSER. Proc. Biol. Soc. Washington **31**: 197–198. December, 1918.

A specimen of *Iole olivacea* from the Anamba Islands in the South China Sea adds this species to their fauna, making altogether 57 species and subspecies of birds now known from this archipelago. It proves to be an undescribed race, and will stand as *Iole olivacea crypta*. It differs very markedly from *Iole olivacea charlottae* of Borneo, but appears to be the same as the bird from Sumatra. H. C. O.

ORNITHOLOGY.—*How to attract birds in the East Central States.* W. L. MCATEE. U. S. Dept. Agr. Farmers' Bull. **912**: 1–15. 1918.

The means of increasing the numbers of birds about the home and elsewhere consist chiefly in methods of protection and provision for nesting places, food, and water. Where feasible the most effectual protection is a vermin-proof fence. Breeding places may be readily furnished by boxes put up for the use of the birds, and water supplied

for drinking and bathing by fountains and open pools. It is most important, however, to provide food. This can be done artificially, particularly in winter, by feeding boxes and similar devices, but the most permanent and practical plan is to plant various seed and fruit producing trees and shrubs. Among the latter, alders, birches, larches, pines, junipers, bayberries, hollies, and similar trees are among the most satisfactory. The trees bearing fruits attractive to birds are here tabulated in a manner to show graphically the duration of the fruit season; and those that are desirable to plant as a protection to cultivated varieties which might be molested by the birds are separately indicated.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*The migration of North American birds. IV. The Waxwings and Phainopepla.* HARRY C. OBERHOLSER. Bird Lore **20**: 219–222. 1918.

This paper contains tables of migration dates for both spring and fall from localities in the United States, Canada, and Alaska, illustrating the migratory movements of *Bombycilla garrula*, *Bombycilla cedrorum*, and *Phainopepla nitens*. All of these species, *Bombycilla cedrorum* particularly, are more or less irregular and erratic in their movements.

H. C. O.

ORNITHOLOGY.—*The status of the genus* Orchilus *Cabanis.* HARRY C. OBERHOLSER. Proc. Biol. Soc. Washington **31**: 203–204. Dec. 30, 1918.

The generic name *Orchilus* Cabanis, proposed for a genus of South American *Tyrannidae*, has commonly had assigned for its type *Platyrhynchus auricularis* Vieillot. Its type is, however, really *Orchilus pileatus Cabanis*, which, since furthermore it is preoccupied by *Orchilus* Morris, makes it a synonym of *Lophotriccus* Berlepsch. This leaves the present genus *Orchilus* without a name, because *Perissotriccus* Oberholser, proposed for *Orchilus ecaudatus* Lafresnaye, is generically distinct from the other species commonly referred to *Orchilus*. This being the case, the new generic name *Notorchilus* is here proposed, with *Platyrhynchus auricularis* Vieillot for its type. H. C. O.

ORNITHOLOGY.—*Three new subspecies of* Passerella iliaca. H. S. SWARTH. Proc. Biol. Soc. Washington **31**: 161–163. December 30, 1918.

A recent study of *Passerella iliaca* and its subspecies, besides indicating

the distinctness of the recently described *Passerella iliaca brevicauda* Mailliard, has revealed the existence of three undescribed subspecies. These are *Passerella iliaca mariposae* from Chinquapin, Yosemite Park, California; *Passerella iliaca fulva* from Sugar Hill, Warner Mountains, Modoc County, California; and *Passerella iliaca canescens* from Wyman Creek, east slope of White Mountains, Inyo County, California.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Washington region.* [December 1917, and January 1918.] HARRY C. OBERHOLSER. Bird Lore **20**: 164–165. 1918.

Notwithstanding one of the severest winters in local annals, there were few of the more northern winter birds about Washington during December 1917, and January 1918. Many of the smaller birds were very irregularly distributed and some of them not as numerous as usual. Hawks of various species were uncommonly numerous close to the city limits. A considerable increase was also noted in *Colinus virginianus* and *Sturnus vulgaris*, both of which were seen in considerable flocks. A single *Plectrophenax nivalis* noted on December 19, 1917, and a single *Lanius borealis* on December 28, are the most notable occurrences. Ducks of various species frequented the Potomac throughout the season in much greater numbers than usual. H. C. O.

ORNITHOLOGY.—*Two new genera and eight new birds from Celebes.* J. H. RILEY. Proc. Biol. Soc. Washington **31**: 155-159. December 30, 1918.

The zoological explorations of Mr. H. C. Raven in the island of Celebes, principally in the northern and middle portions, have resulted in the gathering of a large collection of mammals and birds. In the preliminary identification of the birds, six new species and two subspecies have been discovered, two of the distinct species belonging to new genera. These two new genera are *Coracornis*, a shrike-like bird allied to *Pachycephala* Vigors and Horsfield, of which the type is *Coracornis raveni;* and *Celebesia*, an interesting flycatcher allied to *Malindangia* Mearns, the type of which is the new species *Celebesia abbotti*. The other new species are *Rhamphococcyx centralis*, *Lophozosterops striaticeps*, *Catapenera abditiva* and *Cryptolopha nesophila*. The two new subspecies are an interesting new form of edible swiftlet, *Collocalia vestita aenigma*, and *Caprimulgus affinis propinquus*. HARRY C. OBERHOLSER.

GEOLOGY.—*A geologic reconnaissance of the Inyo Range and the eastern slope of the southern Sierra Nevada, California.* ADOLPH KNOPF. With a section on the stratigraphy of the Inyo Range. EDWIN KIRK. U. S. Geol. Survey Prof. Paper 110. Pp. 130, pls. 23, figs. 8. 1918.

The region described in this report comprises Owens Valley, in eastern California, and the portions of the Inyo Range and the Sierra Nevada between which it lies. The sedimentary rocks of the Inyo Mountains are more than 36,000 feet thick and range in age from pre-Cambrian to Triassic. The Silurian is the only Paleozoic system not represented. The Lower Cambrian of this area is not only notable for its great thickness (10,200 feet), but it contains the oldest Cambrian deposits known on the continent.

Early in Cretaceous time great masses of granitic rocks were intruded, both in the Inyo Range and the Sierra Nevada. The escarpment of the Sierra is composed dominantly of such rocks. Quartz monzonite predominates, and is represented by two varieties—a normally granular quartz monzonite and a porphyritic variety holding large orthoclase crystals, which makes up the summit region of the range. Younger than these is a coarse white alaskite (an orthoclase—albite granite), which occurs in large masses in this part of the Sierra. Notable features of the geology of the region are the great alluvial cones that extend out from the flanks of both ranges into Owens Valley; the two epochs of glaciation recognizable in the moraines in the canyons of the east slope of the Sierra; and the group of basaltic cinder cones on the alluvial slope between Big Pine and Independence, some of which stand on fault lines marked by fresh alluvial scarps.

The region is rich in mineral resources—silver, lead, zinc, tungsten, gold, and marble—and the waters of Owens Lake yield soda and other chemicals. The mines at Cerro Gordo in the Inyo Range have produced more silver-lead ore than any other mine in California. In 1913 large bodies of tungsten ore were discovered in the Tungsten Hills west of Bishop. The ore consists of scheelite associated with garnet, epidote, quartz, and calcite, and is of contact-metamorphic origin. The ore bodies are important additions to the number of recognized contact-metamorphic scheelite deposits, a class of deposits that previously had hardly been suspected as a possible source of tungsten.

A. K.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

THE BOTANICAL SOCIETY OF WASHINGTON

The 135th regular meeting of the Society was held in the Assembly Hall of the Cosmos Club at 8.00 p.m., Tuesday, April 1, 1919; 65 members and 5 guests being present.

Under "Brief Notes and Reviews of Literature," Prof. A. S. Hitchcock exhibited a volume on "A Monographic Study of the Hawaiian Species of the Tribe Lobelioideae," by Prof. Joseph F. Rock. Mr. Walter T. Swingle announced that, while he was in China, he purchased for the Library of Congress a large collection of Chinese books, mostly on natural history.

In a paper on *A poisonous milkweed, Asclepias galioides*, Dr. C. Dwight Marsh gave briefly a history of the loss of sheep in Colorado caused by the eating of the whorled milkweed. He stated that this plant had never been definitely recognized as having a toxic character, but careful feeding experiments demonstrated that it is exceedingly poisonous, not only to sheep, but to cattle and horses. A study of the distribution and habits of the plant shows that the problem of control is one of peculiar difficulty, for in certain irrigated regions, particularly in Colorado, this species is spreading with great rapidity.

Dr. C. H. Kaufman gave a paper on *The genus Cortinarius*, in which he described some of the typical species of the group. The lantern slides that were used were very instructive on the color and form of these brown-spored agarics. He stated that the genus contained over 500 species, of which 200 species have been recognized in the United States. They occur most abundantly in the temperate and colder zones, or in the higher altitudes, being found abundantly northward to the limits of forests and at elevations to the edge of the timber-line. Some species are intimately connected with roots of forest trees, and individual species are limited to special kinds of forests. They develop late in the season, preferring as a rule, the cooler months. Many of these species are highly colored and, as far as known, all are edible.

A joint paper on *A physiological study of Pythium debaryanum Hesse on the potato tuber* was given by Drs. Lon A. Hawkins and Rodney B. Harvey, in which it was shown that there is a correlation between the resistance of the tissue of the potato to puncture and the resistance to infection by the fungus. The paper was illustrated by motion photomicrographs showing the penetration of the cell walls of the potato by the fungus.

An animated cartoon on *The black stem rust and the barberry*, by Mr. G. D. GEORGE, was shown and explained by Dr. H. B. HUMPHREY. The life story of this rust was shown on the film. The story begins with the winter spores on stubble and wild grass and shows a spore germinating, the sporidia blowing to the barberry bush, the formation of cluster-cups on the barberry leaf, the blowing of a spore to the wheat leaf, its germination and the entrance of the mycelium, through a breathing pore, it branching and spreading within the leaf, and the production and dispersion of the red or summer spores, and their escape through the ruptured epidermis to infect other wheat plants.

A motion picture showing the opening of the flower of the night-blooming cereus was contributed by Mr. H. PITTIER. A two-reel film on *Citrus fumigation* prepared as an educational film by the U. S. Department of Agriculture, was also projected.

The program was followed by a social hour with refreshments.

CHAS. E. CHAMBLISS, *Recording Secretary.*

THE ENTOMOLOGICAL SOCIETY OF WASHINGTON

The 322nd meeting of the Society was held May 1, 1919, in the Assembly Hall of the Cosmos Club. Vice-President WALTON presided and there were present 16 members and 1 visitor.

PROGRAM

A. B. GAHAN: *The black grain-stem sawfly of Europe in the United States.* This paper dealt with *Trachelus tabidus* (Fab.), the establishment of which in the United States has recently been discovered. This insect may become a serious pest of small grain, especially wheat, in this country. Some of the points discussed were the distribution both in the United States and in the old world, character of injury, description of adult and larva and comparison with related species, suggestions for control, and bibliography. The illustrations consisted of drawings of the adult, the larva of this and two allied species of similar habit, and a map of the distribution in the United States. The paper is to be published by the Department of Agriculture.

In the discussion of Mr. Gahan's paper Mr. WALTON stated that Mr. McConnell of the Bureau of Entomology has discovered in Pennsylvania a parasite that killed as high as 30 per cent of the sawfly larvae. Dr. QUAINTANCE remarked that this appears to be one of the few cases in which the necessary measures for insect control conflict with good agricultural practice, the rotation of wheat and clover being undoubtedly good agricultural practice and also favoring reproduction of the insect. Mr. Walton took exception to this, stating that forage experts claim better clover can be raised on plowed ground; but planting on stubble is easier and cheaper. Mr. ROHWER stated that sawflies are sluggish fliers, and was of the opinion that if in the rotation the fields to be

planted to grain were far apart the infestation would be considerably reduced. Mr. GAHAN thought that the fact that the species is already widely distributed in both mountain and plains regions indicates considerable ability to spread Mr. WALTON suggested wind as a means of spreading. Mr. ROHWER stated it as his experience that sawflies seek shelter in high winds, and also that the species is perhaps more widely spread than outlined by Mr. Gahan, inasmuch as he has a larva from near Parkersburg, West Virginia, that is probably this species.

NOTES AND EXHIBITION OF SPECIMENS

Mr. SCHWARZ gave an account of a recent visit which he and several other entomologists had made to the Florida Everglades and keys. He described the topography and flora of the region especially contrasting the character of the everglades keys with the Florida keys. He spoke of the occurrence in semi-tropical Florida of the Coleopterous genus *Dendrosinus* (family Scolytidae). The type of this genus, *D. globosus* Eichoff, was described in 1868 from two specimens said to have come from "North America," but the correctness of this locality has always been doubted. However, during this visit to southern Florida, Mr. H. S. Barber discovered an undescribed species of this genus at Marathon (Key Vacas) boring in the solid wood of *Bourreria havaniensis*. This species differs greatly from *globosus*, and the other species of the genus, and Mr. Schwarz presented a description of it for publication in the proceedings of the Society.

Mr. CUSHMAN discussed the larva of the spider parasite, *Polysphincta texana* Gresson, describing its method of maintaining its hold on its host.

Dr. BAKER expressed the opinion that *Neotoxoptera violae* Theo., described from Egypt, is an aberrant form of *Rhopalosiphum violae* Pergande of America since similar forms are obtainable from Pergandes species in greenhouses here. Mr. ROHWER thought that the fact that a form of the American species resembling the African form can be produced in the greenhouse was no proof that the American and African forms are the same species. He objected to the synonymizing of the two until further proof of their identity is obtained. In support of his contention he cited the case of the so-called *Cladius pectinicornis*, one of the rose sawflies, stating that the American form, which has heretofore been considered as the same as the European species, is specifically distinct. Mr. HEINRICH agreed with Mr. Rohwer, stating that in the Microlepidoptera, American species that have formerly been considered the same as European species are rapidly being found distinct, and the European names are being taken out of American literature.

The 323rd regular meeting of the Society was held June 5, 1919, in the Assembly Hall of the Cosmos Club. President SASSCER presided and there were present 22 members and 6 visitors.

R. H. HUTCHINSON: *Experiments with steam disinfection in destroying lice in clothing.* Mr. Hutchinson prefaced his paper with some remarks about the louse, showing lantern slides, illustrating sexual characters, eggs, hatching, and the effect of steam on eggs. Further slides were then thrown on the screen showing field laundry units and a large delousing plant used at debarkation camps, the speaker explaining in detail all the different pieces of apparatus.

Major HARRY PLOTZ, U. S. Army, who was among the visitors, expressed his appreciation of the assistance furnished by Mr. Hutchinson, and told some of his experiences in connection with this work and in the war zone before the United States entered the war. Dr. BAKER was interested in the presence, mentioned by Mr. Hutchinson, of the peculiar yellow body in the nymphs of lice and the fact that it has not been recorded in the literature of the louse. A similar yellow body always occurs in several groups of Homoptera which he had studied. Its forerunner is present in the egg and is carried to the interior at the time of invagination. In parthenogenetic forms its history is tied up with the development of the ovaries. Buckner in a rather extensive paper on the subject has considered it a commensalistic organism. This view, however, is not held by all embryologists.

A. N. CAUDELL: *Notes on Zoraptera.* Mr. Caudell spoke of the biology and systematics of this peculiar order of insects. A point of particular interest was the finding of winged forms by Mr. H. S. Barber, and the fact that the insects have the habit of dealation.

G. C. CRAMPTON: *Phylogeny of Zoraptera.* This paper was presented by title by Mr. Caudell, who exhibited the drawings to be used as illustration in the published paper.

R. A. CUSHMAN, *Recording Secretary.*

BIOLOGICAL SOCIETY OF WASHINGTON

The 597th regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, May 3, 1919; called to order at 8.15 p.m. by Vice-President BAILEY; 30 persons present.

The following informal communications were presented:

A. WETMORE: Remarks on the feeding of purple finches on certain plant galls. The galls were the size of a finger-end and were held in the feet of the birds while being torn open.

L. O. HOWARD: Remarks on the soon-expected arrival of the adults of the seventeen-year locust and the desirability of securing more data on the chimney-building habits of the immature insect. In this connection EDITH R. KELEHER, WM. PALMER, and A. WETMORE reported their observations as to chimney building-habits.

R. W. SHUFELDT: Remarks on and exhibition of a second specimen of double-headed turtle and of a double-headed snake. Both speci-

mens had died in a very immature state. The snake had been identified as *Natrix sipedon*. In this connection E. W. NELSON referred to a double-headed snake observed by him.

The regular program consisted of two communications:

A. WETMORE: *Notes on the brown pelican*. The speaker gave an account of the life and habits of this bird as observed by him on Pelican Island, Florida, in the early part of the present year. His remarks were illustrated by numerous lantern slides. Discussion by E. W. NELSON, R. W. SHUFELDT, A. S. HITCHCOCK, L. O. HOWARD, and I. N. HOFFMAN.

VERNON BAILEY: *The explorations of Maximilian, Prince of Wied, on the Upper Missouri in 1833*. The speaker described the travels of this early naturalist and many of the animals encountered by him. His remarks were illustrated by lantern-slide views of many of these animals and by motion-picture views of many of the larger mammals of the Upper Missouri region. Discussion by R. W. SHUFELDT.

The 596th regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, April 19, 1919; called to order at 8 p.m. by Vice-President HOLLISTER; 43 persons were present.

On recommendation of the Council H. H. LANE, of Norman, Oklahoma, was elected to active membership.

Under the heading, "Book notices, brief notes, exhibition of specimens, etc.," the following informal communications were presented:

W. P. TAYLOR: A brief account of the organization of the American Society of Mammalogists on April 3 and 4, 1919.

T. S. PALMER: Remarks on ornithological activities in Germany during the war as revealed by a recently received ornithological journal published in that country for 1918. Ornithologists appeared to have been active in Germany in spite of the war but their fields of research were necessarily limited through lack of communication with the outside world, but bird problems in Germany, migration records in Germany, including rather complete migration records at Heligoland, and bibliographic matters, especially of African birds, received rather marked attention.

A. S. HITCHCOCK: Remarks on the organization of the National Research Council as pertaining to biology.

The regular program was as follows:

WALTER P. TAYLOR: *Notes on Dr. J. G. Cooper's scientific investigations on the Pacific Coast*. Dr. James Graham Cooper was one of the most active students of birds and mammals on the Pacific Coast in the middle nineteenth century. Born in New York June 19, 1830, he early became interested in the West through his connection with the Stevens Survey of the Pacific Railroad Route along the 47th and 49th parallels. He was most active as a field collecter between the years 1853 and 1866, during which period he worked for more than two years in Washington Territory and collected widely in California. He collected types or

cotypes of eight species of mammals; five specific names and one vernacular name were given in his honor; and he published formal descriptions of four birds, one mammal, and one reptile. His bird papers number twenty-six, his mammal papers thirteen. Before 1860 his interests were in general natural history, embracing botany and meteorology as well as zoology. Subsequent to that time he concentrated his attention on zoology, doing most of his work in conchology and ornithology. He died July 19, 1902, at Hayward, California.

Discussion by T. S. Palmer, A. S. Hitchcock, and L. W. Brown.

C. W. Field: *Observations on the heath hen*, illustrated by lantern slides. Discussion by W. W. Grant, L. O. Howard, R. M. Libbey.

Albert Mann: *Woods Hole diatoms*, illustrated by lantern slides. Discussion by A. S. Hitchcock, Mrs. N. Hollister.

The 598th regular meeting of the Society was held in the Assembly Hall of the Cosmos Club, Saturday, May 17, 1919; called to order at 8.30 p.m. by President Smith; 45 persons present.

The following informal communications were presented:

W. R. Maxon: Exhibition of and remarks on a fungus of the genus *Mitromyces*.

W. R. Maxon: Inquiry as to whether both sexes of birds are known to sing. Discussion by H. C. Oberholser and Wm. Palmer, who cited instances in which the females of certain species of birds are known to sing.

F. V. Coville: Remarks on a vine in the Department of Agriculture having a length of 1134 feet. It was planted 12 years ago and by appropriate trimming can be made to grow 100 feet a year. It roots at intervals of its length so that water and salts are not drawn through its entire length. Discussion by A. S. Hitchcock and W. E. Safford.

A. S. Hitchcock: Remarks on the state of publication of the soon-to-appear flora of the District of Columbia and vicinity.

I. N. Hoffman: Remarks on the recently reported occurrence of several flocks of whooping cranes in Texas.

Wm. Palmer: Remarks on tide conditions of Chesapeake Bay as influenced by winds and storms and observation on the large numbers of dead croakers and of other fishes recently seen by him in the Bay in the vicinity of Chesapeake Beach. These fishes furnished an abundant food for crows and buzzards.

H. M. Smith: Exhibition of and remarks on an exceedingly small (but not the smallest) species of fish, *Lucania ommata* from a small freshwater lake in Georgia.

The regular program consisted of two communications:

F. V. Coville: *The strange story of the box huckleberry.* (To be published in full in a forthcoming issue of *Science*.)

W. E. Safford: *Plants used in the arts and industries of the ancient Americans.*

M. W. Lyon, Jr., *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

MATTERS OF SCIENTIFIC INTEREST IN THE SIXTY-SIXTH CONGRESS

In addition to the large supply bills, which provide for the work of the scientific bureaus of the Government, several measures have been introduced in the first session of the Sixty-sixth Congress which are of special interest to the scientific profession.

The three bills concerned with the tariff and the removal of the duty-free privilege on scientific supplies were published in the preceding number of this JOURNAL, together with a note on the hearings held on the bills.[1] Mr BACHARACH later combined the three bills into one (H. R. 7287) under the title: "A bill to provide revenue for the Government, to establish and maintain in the United States the manufacture of scientific instruments, laboratory apparatus, laboratory glassware, laboratory porcelain ware—an industry essential to national defense." On July 15 a hearing on "surgical instruments" was held before the House Ways and Means Committee, at which Col. C. R. DARNELL, of the Army Field Medical Supply Depot, and representatives of three manufacturers of surgical instruments testified. On July 24 Mr. Bacharach introduced a substitute bill, H. R. 7785, "To provide revenue for the Government, to establish and maintain in the United States the manufacture of laboratory glassware, laboratory porcelain ware, optical glass, scientific and surgical instruments," in which a paragraph was added placing a duty of 60 per cent on surgical and dental instruments. This bill was reported to the House without amendment, and recommended for passage, on July 26 (Report 157).

Federal aid to research is provided for in the following bills:

S. 16 (Mr. SMITH of Georgia): "To establish engineering experiment stations in the States and Territories, in connection with institutions of higher technical education, for the promotion of engineering and industrial research as a measure of industrial, commercial, military, and naval progress and preparedness in times of peace or war." Referred to the Committee on Education and Labor.

S. 105 (MR. GRONNA): "For the promotion of engineering and industrial research." To the Committee on Agriculture and Forestry.

H. R. 1108 (MR. RAKER): "To make accessible to all the people the valuable scientific and other research work conducted by the United States through establishment of a national school of correspondence." To the Committee on Education.

S. 15 and S. 1017 (Mr. SMITH of Georgia), H. R. 7 (Mr. TOWNER), and H. R. 2023 (Mr. RAKER) provide for the creation of a federal Department of Education.

[1] See this JOURNAL 9: 389. 1919.

Special provisions regarding research in the federal bureaus are contained in the following bills and resolutions:

S. 814 (Mr. OWEN): "To establish a department of health and for other purposes." To the Committee on Public Health and National Quarantine.

S. 2380 (Mr. SMOOT): "To provide for an increased annual appropriation for agricultural experiment stations, to be used in researches and experiments in home economics, and regulating the expenditure thereof." To the Committee on Agriculture and Forestry.

S. 2507 (Mr. FRANCE): "To establish an executive department to be known as the Department of Public Health, and for other purposes." To the Committee on Public Health and National Quarantine.

S. 2635 (Mr. FLETCHER): "To authorize the Department of Commerce, by the National Bureau of Standards; to examine and test manufactured articles or products for the owner or manufacturer thereof, to issue a certificate as to the nature and quality of such manufactured articles or products, and to prevent the illegal use of such certificate." To the Committee on Commerce.

H. R. 3736 (Mr. FREAR): "To transfer the Public Health Service from the Department of the Treasury to the Department of the Interior." To the Committee on Interstate and Foreign Commerce.

H. Concurrent Res. 12 (Mr. VAILE, by request): "Requiring a scientific study of values and relative values by the Bureau of Standards." To the Committee on Coinage, Weights, and Measures.

Attempts to relieve the admittedly desperate situation of the Patent Office are contained in H. R. 5011, H. R. 5012, H. R. 6913, and H. R. 7010. These provide for making the Patent Office a separate department of the Government, and for increasing the salaries and personnel. Hearings on these bills were begun before the Committee on Patents on July 9.

Several measures have been introduced to provide for research on the causes, prevention and treatment of the still obscure disease, commonly called influenza, which was epidemic in the United States in the latter half of 1918. These measures include: S. Joint Res. 76 (Mr. HARDING), H. R. 7293 (Mr. BLACK), H. R. 7700 (Mr. LARSEN), H. R. 7778 (Mr. FESS), and H. Joint Res. 159 (Mr. EMERSON). Mr. MYERS has introduced S. 1258, "To prohibit experiments upon living dogs in the District of Columbia or in any of the Territorial or insular possessions of the United States, and providing a penalty for violation thereof." Referred to the Committee on the Judiciary.

At the request of the Engineering Council Mr. JONES of Washington introduced S. 2232, and Mr. REAVIS, H. R. 6649, "To create a Department of Public Works and define its powers and duties." These bills provide for the assembling of all the engineering activities of the Government in one department. The Department of Public Works would replace the present Department of the Interior, and such bureaus

of the latter as are nonengineering in character would be transferred to other departments. The new department would include the following existing organizations: Supervising Architect's Office, Construction Division of the Army, several engineering commissions now under the War Department, Bureau of Standards, Coast and Geodetic Survey, Bureau of Public Roads, and Forest Service. Referred to the Committee on Public Lands.

On July 22 the House passed H. R. 6810, the "Prohibition Bill," introduced by Mr. VOLSTEAD: "To prohibit intoxicating beverages and to regulate the manufacture, production, use and sale of high-proof spirits for other than beverage purposes, and to insure an ample supply of alcohol, and promote its use in scientific research and in the development of fuel, dye, and other lawful industries." One of the amendments accepted on July 21 just before the final passage of the bill was as follows: "That alcohol may be withdrawn, under regulations, from any industrial plant or bonded warehouse, tax free for the use of the United States or any governmental agency thereof, for the several States and Territories, and the District of Columbia, and for the use of any scientific university or college of learning, any laboratory for use exclusively in scientific research, or any hospital not conducted for profit."

Of local interest are S. 2537 (Mr. FRANCE) and H. R. 6237 (Mr. LAZARO, by request): "To revive with amendments an act entitled, 'An act to incorporate the Medical Society of the District of Columbia.'" Referred to the Committees on the District of Columbia.

THE PUBLIC BUILDINGS COMMISSION AND THE SCIENTIFIC BUREAUS

The space available for the Geological Survey, the Bureau of Mines, and other scientific and technologic branches of the Interior Department has been considerably reduced by the action of the Public Buildings Commission, according to the report of that Commission made to the Senate on July 8. Re-allotments of space have also been made in the Departments of Agriculture, Commerce, Navy, Treasury, and War, as well as in the various special war organizations. The apparent saving to the Government from the vacating of rented buildings is estimated at about $350,000. The Geological Survey is restricted to about one-half the floor space it now occupies. Realizing that the work of the Survey cannot be properly done under such conditions and some classes of work cannot be done at all, the scientific and technical force of the Survey have protested this action in the following letter:

"To the Chairman, Joint Commission to assign space in public buildings:

"The undersigned, geologists, engineers, chemists, and other scientific and technical members of the staff of the United States Geological Survey, earnestly protest against the recent action of the Public Build-

ings Commission which will result in reducing the space allotted to the scientific, technical and clerical employees of the Geological Survey in the New Interior Building to 75 square feet per person, or about one-half that now occupied.

"It is beyond argument that the industrial, social, and economic advancement of a nation is largely measured by its capacity to encourage scientific researches and apply their results. The Federal and State governments have recognized this fact by establishing scientific and technical bureaus to aid in the development of the country's resources and the administration of the laws.

"The proper housing of a scientific and technical bureau such as the Geological Survey demands adequate consideration of freedom from interruption, proper lighting and ventilation, and easy access to numerous reference books, drafting tables, valuable maps in various stages of completion, specimens of many materials, and considerable special equipment.

"The Geological Survey in carrying out the work assigned to it by Congress has been able to perform highly useful public service, to draw to its staff men of the highest professional training and ideals, and to create standards of workmanship and efficiency that are well known and widely approved.

"After 30 years of service the Geological Survey found itself housed under crowded and unsanitary conditions that hindered its efficiency, menaced the standards of its work, and sufficiently endangered the health of its employees to call forth a protest from the Public Health Service. At that time the average floor space available to clerical employees was about 64 square feet and to scientific and technical employees about 102 square feet. These conditions led to the preparation of plans for a building especially adapted to the Geological Survey's needs and in 1913 to the passage of the bill authorizing the construction of the New Interior Building, of which the Survey now occupies about one-third.

"The present personnel of the Geological Survey in Washington includes about 320 geologists, engineers, chemists, and other scientific and technical employees, about 260 clerical employees, and 121 skilled mechanics and workmen. By the proposed reduction in allotted space the first two groups, aggregating 580 employees, must carry out their official work in 44000 square feet of floor space, or about 20 per cent less than that occupied by a similar corps of workers in the old crowded and unsanitary quarters.

"Careful investigation gives convincing evidence that an average of at least 150 square feet, or twice that allotted by the Public Buildings Commission, is the minimum within which the employees of the Geological Survey can perform their official duties with proper regard for efficiency and standards of work.

"It is stated that the reduction in allotted space is made in the in-

terest of economy. The members of the Geological Survey are entirely willing to bear their due share of any burdens imposed by a program of national economy, but they protest that the proposed reduction in floor space and the resulting crowding will not be an economy but will actually cause a loss in efficiency exceeding the saving.

"We respectfully request that the Public Buildings Commission reconsider the allottment of space as it affects the Geological Survey."

NOTES

Messrs. H. A. Edson and W. W. Stockberger, of the Bureau of Plant Industry; W. I. Swanton, of the Reclamation Service; C. O. Johns, of the Bureau of Chemistry; J. F. Meyer, of the Bureau of Standards; O. S. Adam, of the Coast and Geodetic Survey; and Sidney F. Smith of the Patent Office are assisting the Congressional Joint Reclassification Commission in the classification of the employees in the Federal scientific bureaus.

The Bureau of Mines is to be divided into an Investigations Branch and an Operations Branch, each with an assistant director in charge. Under the Investigations Branch will come mineral technology, fuels, mining, petroleum, and experiment stations. Under the Operations Branch will be a chief clerk, a division of education and information, the mine rescue work, and the Government fuel yards.

Dr. C. G. Abbot, of the Smithsonian Institution, reports successful observations of the solar eclipse on June 5 at La Paz, Bolivia.

Dr. Samuel Avery, formerly major in the Chemical Warfare Service in Washington, has returned to the University of Nebraska.

Miss Eleanor F. Bliss, of the Geological Survey, and Miss A. F. Jonas are spending three months surveying the crystalline rock area of northeastern Maryland for the Maryland Geological Survey, correlating the Maryland classification and map units with those recognized by these geologists and Miss Florence Bascom, in adjacent portions of Pennsylvania.

Dr. William Bowie, chief of the Division of Geodesy of the Coast and Geodetic Survey, received the honorary degree of Doctor of Science from Trinity College, Hartford, Connecticut, on June 23.

Mr. Stephen C. Brown, registrar of the National Museum for over forty years, died on July 11, 1919.

Mr. W. A. English, formerly a geologist of the Geological Survey and now engaged in professional work in the oil and gas fields of California, has returned temporarily to Washington to complete a report for the Survey.

Mr. Samuel W. Epstein, formerly in charge of the rubber laboratory of the Bureau of Standards at Akron, Ohio, has been transferred to Washington and placed in charge of chemical rubber investigations at the Bureau.

Mr. J. G. Fairchild has been reinstated as assistant chemist in the Geological Survey after seven years of chemical work in other government bureaus and for private interests. During part of this time he studied explosives for the arsenal at Dover, N. J., and more recently nitrous gas problems for the Bureau of Soils.

Mr. R. L. Faris, Assistant Superintendent of the Coast and Geodetic Survey, has been nominated by the President as a civilian member of the Mississippi River Commission, to succeed the late Homer P. Ritter.

Dr. J. Walter Fewkes, chief of the Bureau of American Ethnology, left for the Mesa Verde in July to continue his work in the archeological development of the Park.

Mr. Gerard Fowke, who has been conducting archeological field work for the Bureau of American Ethnology in Missouri, has recently sent to the National Museum a large collection of specimens from the Miller Cave, Pulaski County, the largest and most significant collection yet obtained from a Missouri cave.

Dr. Walter Hough has recently returned from the White Mountain Apache Reservation, Arizona, where he conducted explorations for the Bureau of American Ethnology in a group of large ruins west of Cibecue.

Mr. Hoyt S. Gale, of the Geological Survey, who has spent several months investigating the potash resources of Europe for the Department of the Interior, has made a study of the deposits of Alsace and of Spain, and will study those of Stassfurt, Germany, before returning to the United States.

Capt. Herbert C. Graves, hydrographer in charge of coastal surveys of the Coast and Geodetic Survey, died suddenly in London on July 26 at the age of forty-nine. He had been abroad since June 12 as a representative of the United States at the International Hydrographic Conference, and was also one of the delegates from the American Section of the proposed International Geophysical Union, which met in Brussels in July. He was the Secretary of the Washington Society of Engineers.

Dr. E. C. Harder has again taken up his work in the iron and steel section of the Geological Survey, after spending four months on leave of absence in geological investigations in Brazil for commercial interests.

Mr. J. N. B. Hewitt, ethnologist of the Bureau of American Ethnology, returned to Washington in July, after extended field studies among the Onondaga near Syracuse, New York, and the Mohawk, Aaynga, and Onondaga on the Grand River Grant near Brantford, Ontario.

Mr. J. C. Hostetter has resigned from the Geophysical Laboratory of the Carnegie Institution, to take up research and development work for the Steuben Glass Works, of Corning, New York.

Mr. F. B. LANEY, who was detailed in 1913 to the Bureau of Mines for cooperative research on complex and refractory ores, has returned to the Geological Survey where he will continue his research work on the metalliferous ores. After five years at the Colorado, California, Utah, and Pittsburgh stations of the Bureau of Mines, he took charge of a government metallographic laboratory at Pittsburgh where he co-operated with the Ordnance Department of the Army during 1918 and 1919 in the microscopic examination of metals and alloys used in the manufacture of ordnance.

Dr. WILLIS T. LEE has returned to the Geological Survey after six months' leave of absence, during which he was head of the department of geology and director of the School of Engineering Geology of the University of Oklahoma.

Wesleyan University at its recent commencement conferred the degree of Doctor of Science on Dr. F. B. LITTELL, astronomer of the Naval Observatory.

Mr. E. RUSSELL LLOYD resigned on July 12 as geologist in charge of petroleum resources in the Division of Mineral Resources of the Geological Survey. He is now geologist for the Ohio-Cities Gas Company.

Mr. FRANCOIS E. MATTHES, of the Geological Survey, gave a series of lectures in Yosemite National Park during the month of July, under the auspices of the university extension division of the University of California. The subjects were as follows: July 8: *Origin of the Yosemite Valley, as indicated in the history of its waterfalls.* July 9: *The highest ice flood in the Yosemite Valley.* July 12: *The origin of the granite domes of Yosemite.*

Mr. CARL W. MITMAN has been appointed Curator of the Division of Mechanical Technology in the Smithsonian Institution.

Mr. C. H. OBER of the Coast and Geodetic Survey has been granted leave of absence to go with Dr. ALEXANDER RICE's expedition to the Amazon River.

Mr. SIDNEY PAIGE has resumed his duties at the Geological Survey after six months' leave of absence spent in professional work in the northern part of South America.

Mr. JOHN L. RIDGWAY, chief of the section of illustrations of the Geological Survey, has returned from a month's leave of absence spent in a trip to the Pacific Coast.

Dr. CHARLES C. SCALIONE, formerly a lieutenant in the Research Division of the Chemical Warfare Service, has been appointed assistant catalytical chemist in the Fixed Nitrogen Research Laboratory of the Nitrate Division, Ordnance Department, at the American University.

Dr. H. L. SHANTZ, of the Bureau of Plant Industry, has been appointed botanist with the expedition to South and Central Africa which sailed from New York in July under the direction of Mr. EDMUND

HELLER, of the American Museum of Natural History. Mr. RAVEN, of the Smithsonian Institution, accompanied the expedition as naturalist in charge of zoological and anthropological collections. The expedition will proceed from Cape Town to Victoria Falls, cross into the Belgian Kongo, and then travel east to Lake Tanganyika, and will be abroad for at least one year.

Mr. R. L. V. STRATTON, who enlisted from the Geological Survey to serve as paymaster in the Navy during the war and was stationed at the Virgin Islands for about eighteen months assisting the new American government of the islands in various capacities, has joined with RALPH W. RICHARDS, formerly a geologist of the Survey, in an engineering firm with offices in Washington. They will specialize on the evaluation of oil and gas properties and the determination of income taxes on such properties.

Dr. J. B. UMPLEBY, of the Geological Survey, has returned from Paris, having been temporarily under the State Department assisting the American delegation at the peace conference in mining matters.

Dr. T. WAYLAND VAUGHAN, Mr. D. DALE CONDIT, and Dr. C. WYTHE COOKE, of the Geological Survey, have returned to Washington after spending several months in a geologic reconnaissance of the Dominican Republic for the Dominican Government. Mr. C. P. ROSS, who was also a member of the party, has remained a few weeks longer to make special examinations of the water resources in the vicinity of Samaná Bay. Dr. Vaughan also visited Port-au-Prince, Haiti, and made arrangements with the Haitian Government for a preliminary geological survey of Haiti. At the request of the Navy Department he later made geologic reconnaissances at various other points in the West Indies.

Mr. C. M. WEBER, of Balabac, Philippine Islands, has donated to the National Museum an unusually fine series of Philippine land shells, including new forms.

Dr. R. C. WELLS, of the Geological Survey, has returned from a visit to the Marine Laboratory of the Carnegie Institution of Washington at Tortugas, Florida, where he made a number of chemical determinations on water collected directly from the sea.

Mr. DEAN E. WINCHESTER has returned to the Geological Survey after a month's absence, during which he was engaged in a search for mineral fuels on the island of Jamaica for private interests.

Mr. ROBERT H. WOOD has returned to professional work in the oil and gas fields of Oklahoma, after spending several months in Washington completing reports left unfinished when he left the Geological Survey a year ago.

// JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 9 SEPTEMBER 19, 1919 No. 15

CHEMICAL CRYSTALLOGRAPHY.—*Ammonium picrate and potassium trithionate· optical dispersion and anomalous crystal angles.* HERBERT E. MERWIN. Geophysical Laboratory.

The optical properties of these two compounds were obtained in connection with certain researches on other subjects, and are placed on record here for the benefit of other microscopists.

Ammonium Picrate.—The following observations were made on four samples variously prepared: The crystals are orthorhombic; a sample recrystallized from water consisted of thin scales $\|$ (010); a sample not recrystallized contained slender prisms elongated $\| \dot{c}$; one recrystallized from ammonium hydrate contained equant. grains. Measurements of two prisms corresponded satisfactorily with previous measurements.[1] Refractive indices observed microscopically were: $\alpha = 1.51_0$, $\beta = 1.87_0$, $\gamma = 1.91_0$. The orientation is $\alpha \| \dot{c}$, $\beta \| a$, $\gamma \| b$ for light wavelengths greater than 541 $\mu\mu$; and $\alpha \| \dot{c}$, $\beta \| b$, $\gamma \| a$ for shorter wave-lengths. 2E for $546\mu\mu = 19°$, $578\mu\mu = 51°$, $600\mu\mu = 60°$, $635\mu\mu = 71°$, $675\mu\mu = 82°$, $528\mu\mu = 33°$, and $513\mu\mu = 45°$ to 55°.[2]

The absorption from $700\mu\mu$ to $500\mu\mu$ is $\alpha < \beta = \gamma$. The original crystals and those recrystallized from ammonium hydrate contained streaks which for γ and β were much redder than the main parts of the crystals. The streaks were optically continuous with the rest of the crystal and showed no significant differences in refraction.

[1] See discussion and observations by H. Baumhauer, Zeits. Kryst. 49: 125. 1911.

[2] Baumhauer found for *Li* and *Na* values of 80° (about) and 56°.

From two natural prisms (110) $\wedge$ (0$\bar{1}$0) refractive index measurements gave:

λ = 578	546	529	518+	513+	507
β' = 1.886	1.926	1.956	1.980	1.995	2.015 = γ'
α =	1.516+				

These values are in line with those of Baumhauer, and give (with the orientation and 2E) data for calculating β and γ. That is, $\beta' = \beta +$ 21 to 22 per cent of $(\gamma - \beta)$. Therefore the following dispersion:

TABLE 1

DISPERSION OF AMMONIUM PICRATE

λ	α	β	γ	2V	2E
668	1.499	1.815	1.880	41°+	80°
588	1.508+	1.872	1.908	29	56
546	1.516+	1.925+	1.930	10	19
541	1.518	1.933	1.933	0	0
528	1.522	1.944	1.961	17	33
513	1.528	1.960	2.004	23–28	45–55

Baumhauer's observations on potassium picrate show that it is very like ammonium picrate. The wave-length for which it is uniaxial is evidently shorter than for the ammonium salt. It seems safe to infer that this wave-length is practically that of the helium green line 502, for which he obtained a single signal when measuring the dispersion of β and γ.

Potassium Trithionate.[3]—Blades about 1 cm. long were obtained by cooling a hot saturated solution to room temperature. The prism angles of these blades were not normal, but as follows (the dome angle was normal): 7 crystals, 10 *m* faces, 23 *l* faces, 10 *q* faces.

$$l \wedge l\ 39°\ 0' - 39°\ 27' \quad \text{mean} = 39°\ 13'$$
$$m \wedge m\ 70\ \ 42 - 70\ \ 50 \quad \text{mean} = 70\ \ 46$$
$$q \wedge q\ 45\ \ 13 - 45\ \ 39 \quad \text{mean} = 45\ \ 31$$

At the base of the blades there were numerous stubby crystals, with normal angles. One of these gave the angles

$$l \wedge l = 39°\ 31'$$
$$m \wedge m = 71\ \ 3$$

[3] The crystals were prepared and tested by E. T. ALLEN.

A second lot of 5 crystals made from a corresponding mother liquor by evaporation at room temperature gave the following angles which are normal:

14 faces, $l \wedge l$	39° 20′ — 39° 40′	mean 39° 32′
5 faces, $m \wedge m$	71 0 — 71 15	mean 71 8
6 faces, $q \wedge q$	45 26 — 45 40	mean 45 30

The prisms of the rapidly-grown crystals represent thinner wedges than normal, as if the tendency toward skeletal growth parallel to the *b* axis had caused an actual lengthening of that axis.

The optical dispersion (α and β), of one crystal from each lot was determined from natural faces (*m*), and several less accurate determinations of refractive index made on crystals having good *l* faces. No differences of refractive index greater than ±0.001 were found. Chemical tests do not indicate any solid solution.

TABLE 2

DISPERSION OF POTASSIUM TRITHIONATE.

λ	α ±0.0001	β ±0.0001	γ ±0.002
436	1.5040	1.5805	1.621
486	(1.4993)	(1.5732)	1.612
546	1.4954	1.5673	
578	1.4941	1.5649	
589	(1.4934)	(1.5641)	1.602
656	1.4909	1.5607	
691	1.4903	1.5591	1.596

$2V_{Na}$ measured 72° ± 3°, with no noticeable dispersion. The above indices make 2V = 70° ± 1°.

BOTANY.—*On the origin of chicle with descriptions of two new species of Achras.* H. PITTIER, Bureau of Plant Industry.*

Many statements in cyclopedias, handbooks, and even special treatises, considered as facts, are really the expression of mere rumors collected by travellers and reproduced without the necessary discrimination.

Thus we find in almost all the literature of cacao, that this product is the crop of a tree scientifically called *Theobroma cacao*

* Published with the authorization of the Secretary of Agriculture.

L., whereas it is a fact that the larger portion of the cacao beans seen in the world market proceeds from another species, *Theobroma leiocarpa*, described fully fifty years ago by the Swiss botanist Bernouilli.[1]

The general idea is also that the Central-American rubber originates from a single species, *Castilla elastica*. In reality, as far back as 1903,[2] O. F. Cook called attention to the existence of several distinct rubber-producing species of Castilla, of which he published no less than four in 1905.[3] In 1910, the writer took up the same subject and completed to a certain extent Cook's work, with the addition of a few more species.[4] Among other things, he showed that *Castilla elastica* is a species with a very limited area in the states of Vera Cruz, Tamaulipas, and Michoacan, Central Mexico, and that most of the seeds used in building up the plantations of Ceylon and other countries in the East and West Indies and South America, proceeded from the several species scattered over Central America. Nevertheless, the notion is generally maintained that Castilla rubber is the exclusive product of *Castilla elastica*. Even the distorted name *Castilloa*, with the addition of a superfluous vowel, passes stereotypically from old publications to those of more recent date.

So far, the origin of another Tropical American product, the *chicle*, has not been questioned. It was admitted everywhere that *Achras Zapota* L., an important fruit tree known as *sapodilla* or *naseberry* in English, and in Spanish as *zapotillo*, *chicozapote*, and *níspero*, was also the only producer of this substance, which is the base of the American chewing gum and is also applied to several other uses. On the authority of travellers like Morelet and of other authors, I myself recorded that species as "abundant in the lowlands of Tabasco and Chiapas and the western part of Yucatan" (see footnote 4) as well as in Jamaica and parts of Venezuela, without ever suspecting that I was contributing to the further spreading of a fallacy.

[1] In Denkschr. Schweiz. Naturforsch. Ges. 29: 1–15, pl. 1–7. 1869.

[2] *The culture of the Central-American rubber tree*, U. S. Dept. Agr., Bur. Pl. Ind., Bull. 49.

[3] Science, n. ser. 18: 438. 1903.

[4] Contr. U. S. Natl. Herb. 13: 247–279, pls. 22–43, figs. 45–54. 1910.

My first doubts originated in Venezuela in 1917, when a friend, with a certain botanical knowledge acquired under the late Dr. Ernst, reminded me of the fact that *chicle* is one of the export products of the Orinoco Valley, adding that he had seen one of the trees from which the gum is extracted and did not believe it to be *Achras Zapota*, but perhaps a Mimusops, not unlike the *pendare*, the *purvio*, or the *masarandú*, from which the Venezuelan balata gum is obtained.

At the time, however, I gave little attention to the subject: everybody said that the chicle was obtained from the *níspero* tree and *níspero*, that is to say, Achras Zapota, it had to be. But very recently, in May of the present year, on the occasion of an official exploration of the region between the rivers Motagua and Chamelecon in Guatemala and Honduras, respectively, I came face to face with one of the so-called *nósperos*, which I could not, at first, recognize as a species of Achras. The tree, nearly one meter in diameter at the base and at least 35 meters high, was met on the first hills on the trail from Los Amates to El Paraiso, beyond La Francia, in the Molhá valley. At first sight, it had the appearance of a Mimusops, but the numerous, freshly detached corollas which covered the soil under the tree completely lacked the dorsal lobular appendages which are characteristic of this genus. Of course, this indicated a close relationship with Achras Zapota, except that the corollas were rotate or almost so, while in the latter they are tubulose; but the fact that Achras has been so long considered as a monotypic genus helped on the moment to discard the idea of its belonging to this genus.

At the time the study of the floral details could not well be pursued further, so I simply resolved to obtain more complete materials, and meanwhile started on another line of investigation. I had with me no less than six *monteros*, *i. e.*, woodsmen, some from Honduras, the others from Guatemala, and five of them had worked at the extraction of chicle. On my asking about the name of the tree, the unanimous answer was *níspero;* all agreed, too, that the fruit was edible, like that of the chicozapote; but when I asked whether this níspero and the chicozapote

were identical, the opinion was divided, one of the men explaining that there were several kinds (*varias clases*) of *nísperos*, two of which were bled for the milk. These two grew wild in the forest but the one cultivated near the houses for the fruit was never tapped, nor used as timber. Of the former two, one is met with on the valley flats and is better than the other, which always grows on hills. On my asking in what the difference consisted, I was told that the milk of the tree growing in lower exposures needed one boiling only, while the other required two. Just here, let me state that I know nothing about the technique of the raw chicle preparation, and the expedition in question was such a hurried one that I had no time to go deeper into the subject than to obtain from other persons full confirmation of the above data.

Further information tends to verify the above and to show that chicle is really the product of several species, belonging possibly to more than one genus, of the Sapotaceae. From notes taken by G. N. Collins in his expedition to Yucatan and Tabasco in 1913, it appears that there are differences in the chicle-producing trees, both in the leaf and fruit characters and in the quality of the gum. The trees growing above the 300-meter contour line, although similar in every other way to those growing at lower altitudes, do not produce latex. We have seen that in the Motagua Valley, the latex of trees on the hills is somewhat different from that of trees on the flats. Mr. Collins gives also the information that the average yield is 9 pounds per tree, and reaches up to 25 pounds. To show the importance of the product, we may add here that Mr. Collins' informant exported three million pounds of the gum during 1912.

Another tree having a floral structure identical with that found in Guatemala, and also described below, was discovered in the calcareous zone of the Chagres Valley in Panama. If we admit that both species really belong to Achras, it becomes out of the question to continue considering this genus as monotypic, and since it is now increased to three members, there is no reason why other species having so far escaped botanical collectors,

may not exist in Colombia and Venezuela, the flora of which countries is very imperfectly known.

Lastly it appears from the "Notes on Useful Plants of Mexico," published by Dr. J. N. Rose,[5] as well as from the reports of the *Comisión Catastral y de Estudio de los Recursos naturales del Estado de Sinaloa* (March, 1919), that other Sapotaceae, such as *Calocarpum mammosum* Pierre, *Bumelia Palmeri* Rose, and perhaps certain species of Lucuma, are to be included among the chicle-producing plants. Rose, however, emphasizes the importance of *Achras Zapota* as the main source of the chewing gum, though he adds also that the chicle extracted from *Calocarpum mammosum* is the best gum for masticatory purposes. According to the *Comisión Catastral de Sinaloa*, chicle is obtained there from the fruits of the *bebelamas*, which has just been mentioned under the name of *Bumelia Palmeri*. This tree was also collected in Sinaloa in 1891 by Dr. Edward Palmer, and in 1910 by Rose, Standley, and Russell, but no mention is made of its properties, further than the note by Palmer that children are very fond of the berries.

That the wood of Achras Zapota is not generally used as building material or for other purposes, mainly on account of its being very scarce, is confirmed by reports obtained by me in several Central and South American countries. This wood, being heavy, fine grained, and hard, takes a beautiful polish. But the tree is spared on account of its fruits; furthermore, it seldom reaches adequate dimensions. Although there are trees no less than 20 meters high, most of the height goes into the crown; the trunk is rather short and only about 40 cm. in diameter at most. Ernst[6] refers to its being employed in Venezuela for making barrel staves, but there are other *nísperos* in that country, and the same conclusion may have been drawn. The wood of the *níspero* (*Achras chicle*) noticed by me in the Motagua Valley is considered by the natives as incorruptible and may have been used by the Mayas for the door lintels of their monuments. In the rain forests of the Atlantic coast of Panama, I have

[5] Contr. U. S. Nat. Herb. 5: 222. 1897.

[6] La Exposicion nacional de Venezuela en 1883: p. 218. 1884.

noticed that while most fallen trees are quickly reduced to mould, the trunks of the balata-producing Mimusops, called also *níspero*, would lie almost indefinitely, keeping in perfect condition.

From what has been explained so far, the following conclusions can be drawn:

1. The *nísperos* of Central and South America include several species of Achras, Mimusops, and other genera of the Sapotaceae, so that the name does not necessarily correspond to *Achras Zapota*.

2. The chicle of commerce is not extracted exclusively, if at all, from the latter species, but mainly from other trees with the same vernacular name.

3. The famous door lintels of the ruins of Yucatan were not made from the wood of *Achras Zapota*, but more likely from one of the other *nísperos* in the region.

4. The neotropical genus *Achras* is not monotypic. Besides *A. Zapota* L., it includes up to the present, two more Central American species, and others may come to light when the flora of northern South America is thoroughly listed.

5. Considering the importance of the product, a further, careful investigation of the facts, *in loco*, that is to say, in the valleys of the Motagua and Rio Dulce, in Peten, Yucatan, and Tabasco, is necessary, and should cover the months of April, May and June, so that specimens in flower and fruit, as well as wood samples, could be procured.

Following are the descriptions of the two new species of Achras:

Achras Chicle Pittier, sp. nov.

A large, deciduous laticiferous tree, reaching a height of 25 m. and over, with a basal diameter of 50 cm. and over, the trunk straight, with a rugose or scaly bark, the crown high and elongate, the branchlets thick and glabrous.

Leaves alternate, petiolate, coriaceous, congested on the new growth at the end of the branchlets; petioles subterete, narrowly canaliculate, puberulent, 2.5 to 3 cm. long; leaf-blades obovate-elliptic, long-cuneate at the base, subacute at the apex, 12 to 20 cm. long, 4 to 7 cm. broad, glabrous, dark green and dull above, light green and almost glaucescent beneath; costa impressed above, very prominent beneath, the primary veins numerous, parallel, inconspicuous. Stipules not seen.

Flowers very numerous, congested at the end of the branchlets, the pedicels 1.4 to 1.8 cm. long, puberulous; sepals 6 (3 + 3), those of the

outer whorl imbricate, ovate, slightly connate at the base, rounded at the apex, grayish pubescent without, glabrous and purplish within, about 7 mm. long and 3.5 mm. broad, those of the inner whorl valvate, oblong, obtuse at the apex, densely grayish pubescent without, purplish and glabrous within, 7 mm. long and 2.5 to 3 mm. broad; corolla rotate, 6-lobulate, glabrous, white, the tubular part 1 5 mm. long, the lobes exappendiculate, ovate-lanceolate, obtuse, about 6 mm. long and 4 mm. broad; stamens and staminodes connate at the base, inserted at the same height, 2 to 2.5 mm. from the base of the corolla, the former slightly exserted, the filaments terete, attenuate, about 5 mm. long, the anthers extrorse, dorsifixed ovate or ovate-lanceolate, cordate at the base, obtuse, about 3 mm. long; staminodes petaloid, ovate-acuminate, broad at the base, subacute, about 4 5 mm. long, irregularly toothed or laciniate; pistil 8 to 8.5 mm. long, substipitate, the ovary globose-depressed, deeply sulcate, minutely fulvo-pubescent, about 1 mm. high, 2 mm. in diameter, 7-, 8- or 9-celled, the cells uniovulate; style slender, slightly attenuate, about 7 mm. long, adpressed, hairy at the base, glabrous higher, the apical stigmatic surface papillose, minutely tuberculate.

Fruit globose-depressed, about 3.5 cm. long and 4 cm. in diameter, the pedicel thick, about 2 cm. long. Skin brown-ferruginous, almost smooth; mesocarp and dissepiments fleshy, succulent, with 4 to 6 seeds, more or less. Seeds large, compressed, ovate, slightly curved, brownish and dull, 2.3 cm. long, 1.4 to 1.7 cm. broad, 6 to 7 mm. thick, the margin smooth, slightly thickened, with a small, narrow, inconspicuous cicatricula.

Type in the U. S. National Herbarium, collected in flower at Vega Grande near Los Amates, Department Izabel, Guatemala, at about 200 meters above sea-level, May, 1919, by H. Pittier (no. 8537).

At first sight, this species reminds one of the Mimusops of the *manilkara* group, an impression that is not sustained by a closer examination of the corolla, in which the absence of dorsal appendages is instantly noticed. This detail, added to the presence of six petaloid staminodes, places this species among the Sideroxyleae rather than among the Mimusopeae. Furthermore, the genus Achras seems to be indicated by the hexamerous floral envelopes and androceum. But the corolla is plainly rotate, with a very short tube (almost 4 times shorter than the lobes) and not urceolate with the tube half as long as the lobes; the margin of the lobes is entire and not sinuate, the design of the staminodes is quite distinct, the stamens and style are exserted, and the ovary cells do not seem ever to be more than 9. If the dorsal appendages of theCorolla were present, we would have a perfect Mimusops, without them, but with the sepals distinctly biseriate, the corolla tube very short, the ovary cells at the most 9, I felt reluctant at first to place the tree under Achras. On the other hand, the fruit

and other characters indicate such a close relationship that I am confident the decision to place the species in this genus will be supported by further study. It seems preferable to introduce a few slight modifications in the generic definition rather than to create a new division in the already oversplit and somewhat confused order Sapotaceae.

Achras calcicola Pittier sp. nov.

A deciduous, laticiferous tree, 15 to 25 meters high, often over 1 meter in diameter at the base, the trunk usually straight, covered with a 2 cm. thick, rimose bark, the crown reduced, depressed, the branching divaricate; latex white; wood hard, reddish.

Leaves alternate, petiolate, congested at the end of the branchlets, coriaceous, entirely glabrous; petioles terete, canaliculate, 2 to 3 cm. long; leaf-blades obovate-oblong, cuneate-attenuate at the base, shortly obtuse-acuminate at the apex, 8 to 18 cm. long, 3 to 6 cm. broad, dark green and dull above, pale green beneath, the costa impressed on the upper face, prominent beneath, the primary veins numerous and inconspicuous.

Flowers numerous, pedicellate, congested at the base of the leaves at the end of the branchlets; pedicels more or less pubescent, about 1 cm. long; sepals 6 (3 + 3), ovate or ovate-oblong, attenuate toward the apex, the exterior ones 5.5 mm. long, 3.5 to 4 mm. broad, densely fuzzy-pubescent without, the interior ones a little longer and narrower, pubescent at the apex, ciliate on the margin; corolla white, broad campanulate or almost rotate, glabrous, 6-lobulate, the tubular part 1 mm. long, the lobes ovate-acute, 3.5 to 4 mm. long, imbricate, sometimes denticulate on the margin, exappendiculate; stamens and staminodes 6, connate at the base, inserted at the apex of the tube; stamens as long as the corolla lobes, the filaments terete, apiculate, about 2.5 mm. long, the anthers extrorse, dorsifixed, emarginate at the base, obtuse, about 3 mm. long; staminodes petaloid, ovate, bifid, about 4 mm. long, the margin irregularly denticulate; pistil 4.5 to 5 mm. long, the ovary globose-depressed, more or less distinctly sulcate, 9-celled, stiff-hairy; style obtuse, glabrous. Fruit not known.

Type in the U. S. National Herbarium, no. 678503, collected in flower, in the dry forests on Eocene limestone around Alhajuela, Chagres Valley, Panama, May, 1911, by H. Pittier (no. 3457).

This species differs from *Achras Zapota* L. in the acuminate leaves, the smaller flowers, the broadly open corolla with short tube, the insertion, size, and shape of the stamens, and the 9-celled ovary. It shows more affinities with *Achras Chicle*, just described, but has smaller flowers, the parts of which also differ in shape and size.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

GEOLOGY.—*The oil fields of Allen County, Kentucky.* EUGENE WESLEY SHAW and KIRTLEY F. MATHER. U. S. Geol. Survey Bull. **688.** Pp. 120, pls. 36, figs. 10. 1919.

This report is designed to be purely geologic in nature, and the reconnaissance field work included the determination of the general lay of the rocks and details of structure in certain areas. The dips are generally too low to be read by the clinometer. Few of the beds of this region can be followed any considerable distance, though by means of fossils the stratigraphic position of beds outcropping many miles apart can be determined within a few feet. As the oil sand lies not more than 200 feet below the valley bottoms, most of the drilling is done with machines. There is no forrest of derricks but instead inconspicuous pumping jacks scattered through the woods and fields of a somewhat hilly region.

The stratigraphy is described in detail. The pay sands occur in the "Corniferous" limestone of Devonian age and the Silurian lime-stone. The capacity and life of wells, and the origin, source, and mode of accumulation of the oil are discussed, favorable structures are shown and suitable locations for drilling are suggested. Circumstantial evidence points to the derivation of the oil from plant remains, particularly spore cases of ferns and related plants. R. W. STONE.

GEOLOGY.—*The Kantishna Region, Alaska.* STEPHEN R. CAPPS. U. S. Geol. Survey. Bull. **687.** Pp. 112, pls. 17, figs. 6. 1919.

The Kantishna region lies between Fairbanks and Mt. McKinley and west of the railroad from Seward to Fairbanks. The area described includes about 4500 square miles. Geologic reconnaissance shows four pre-Tertiary formations—Birch Creek schist, the Tatina and Tonzano groups, and the Totatlanika schist. In none of these rocks

have fossils been found, and their differentiation and correlation is based largely on lithologic and stratigraphic grounds. Younger formations consist of sands and gravels, shales, lignitic beds of Tertiary age and a great abundance and variety of Quaternary deposits. The productive gold placer deposits of the district are all in the basins of the streams that head in the Kantishna Hills. A large part of the gold of the stream placer gravels was derived by erosion from the fissure quartz veins that cut the Birch Creek schist. The veins which carry gold, silver, and antimony have been prospected but the inaccessibility of the region has prevented their development. R. W. Stone.

GEOLOGY.—*Some American cretaceous fish scales*. T. D. A. Cockerell. U. S. Geol. Survey Prof. Paper **120–I**. Pp. 165–202, pl. 7. 1919.

Fish remains are extremely abundant in several Cretaceous formations of the Rocky Mountains and Great Plains, but except in the Niobrara formation of Kansas, a fish skeleton well enough preserved for description or identification is the greatest rarity. In the original descriptions of both the Mowry and the Aspen shales of Wyoming the presence of fish scales is mentioned as a characteristic feature.

Descriptions of scales without figures are unsatisfactory, especially if they are to be largely used by stratigraphers who have no intimate knowledge of lepidology. Consequently it has been considered necessary to illustrate this paper fully, with enlarged figures, from photographs.

This discussion deals almost entirely with a marine fauna. So far as known at present the Tertiary fishes mark a considerable advance on or at least change from their Cretaceous predecessors. It ought to be possible as a rule to distinguish a Cretaceous from a Tertiary deposit by means of a single well-preserved fish scale. The exceptions will be found in those groups which range with little change from the Cretaceous to the present day—the berycoids, clupeids, or hemiramphids. Just as the Tertiary fishes mark an advance on the Mesozoic, so also the later Cretaceous fishes present evidence of evolution and modernization. This statement applies not only to the Upper as contrasted with the Lower Cretaceous, but also, and rather markedly, to the Montana group as contrasted with the Colorado group. Thus evidence is found of a rather slow and gradual modernization of the fish fauna, the breaks in the series corresponding with the geologic breaks and not being attributable to any extraordinary migrations or sudden new develop-

ments. Scales of fishes from the Chico, cut off from the inland sea by the western uplands, are all different from those in Rocky Mountain deposits. The Chico has a veritable clupeid, but so far no genuine clupeids have been found in the Benton, Niobrara, Pierre, or Fox Hills. The inland waters seem to have lacked berycoids, which are so characteristic of the European strata. R. W. STONE.

GEOLOGY.—*Structure and oil resources of the Simi Valley, Southern California.* W. S. W. KEW. U. S. Geol. Survey Bull. 691-M. Pp. 323–347, pl. 4, fig. 1. 1919.

This report describes a small oil field about 32 miles northwest of Los Angeles, in the Simi Valley, Ventura County. All the rocks within the Simi Valley district are of sedimentary origin with the exception of a few small areas of basic igneous rocks of Miocene age. The greater part of the Simi Hills is composed of rocks of Chico (Upper Cretaceous) age. In the Simi Valley district, as in other localities in California, the Eocene comprises both the Martinez (lower Eocene) and the Tejon (upper Eocene) formations. Although these divisions are elsewhere separated by an unconformity, the series, consisting of 3,500 to 6,500 feet of conglomerates, sandstones, and shales of various types, here appears to be homogeneous.

The Monterey group (Miocene), which in the Simi Valley district is divided into the Vaqueros sandstone and Modelo formation, is one of the most widespread series of rocks in California. The Fernando formation is exposed in a series of irregular areas along a synclinal region between the Santa Susana Mountains and the Simi and San Fernando valleys. It lies with a marked unconformity on all the older formations.

The structure, or attitude of the different strata in the Santa Susana Mountains and Simi Valley is closely related to that of the California Coast Range, which is characterized by a number of northwestward-trending folds, broken by faulting. The Simi Valley oil district lies in the midst of the westward-trending ridges of the Coast Ranges and embraces a part of two large structural features, the Santa Susana Mountains and the Simi Hills. In this region the dominant structure is a result of compressive forces which acted from north to south at the end of the Pliocene epoch. The principal structural feature in the Simi district is the Santa Susana fault which follows closely the foot of the steep southern front of the Santa Susana Mountains. The Simi anticline is economically the most important structural feature

in the Simi region at the present time on account of its association with the Simi oil field.

As the object of this paper is to make recommendations bearing on both developed and possible new territory in the Simi Valley, the conditions under which the oil occurs in the field situated on the flanks of the Santa Susana Mountains and Oak Ridge are briefly reviewed. The more productive wells according to the records appear to be either along the axis of the anticline or immediately north of it.

R. W. Stone.

GEOLOGY.—*Anticlines in a part of the Musselshell Valley.* C. F. Bowen. U. S. Geol. Survey Bull. 691-F. Pp. 185–209, pl. 1. 1918.

Previous investigations had shown that the Musselshell Valley, Montana, is an area in which the rocks have undergone considerable folding. The work has demonstrated the existence within the area studied of several well-developed anticlines and domes, which seem to offer structurally favorable places for the accumulation of oil and gas. The demonstration of the presence or absence of commercial accumulations of these fluids in the folds has been less conclusive, owing largely to the undeveloped condition of the area.

Sandstones that would serve as suitable reservoirs for the accumulation of oil occur at several horizons. (1) Near the top of the Colorado shale there is a transition zone of thin sandstones and sandy shale beds. (2) About 1200 feet below the top of the Colorado. (3) About 250 to 300 feet lower in the section is another sandstone of similar character, but much thinner and more distinctly conglomeratic. (4) Associated with and underlying the Mowry shale member, in the eastern part of the field, are several thin, finely conglomeratic sandstones. (5) At the top of the Kootenai there is 40 to 50 feet of platy, rather fine grained sandstone in approximately the same position as the Greybull sand of the Big Horn Basin, Wyoming. (6) Near the base of the Kootenai there is another coarse, porous sandstone of undetermined thickness.

The Eagle sandstone is not a likely source of oil or gas in most of this area, for it has been removed from the crests of most of the anticlines, and thus any oil or gas that may have originally been stored in it has had an opportunity to escape.

This report discusses the geology of the region as a whole, and also suggests the most favorable places for future development.

R. W. Stone.

GEOLOGY.—*Oil and gas geology of the Birch Creek-Sun River area, Northwestern Montana.* EUGENE STEBINGER. U. S. Geol. Survey Bull. **691**-E. Pp. 149–184, pl. 1, figs. 3. 1918.

The purpose of this paper is limited to a presentation of the field evidence having a bearing on the oil and gas prospects of the area, including a description of the broader features of the geology and more detailed accounts of local structural features that seemed to be possible sources of oil and gas.

All the formations in the Birch Creek-Sun River area are of sedimentary origin. Exclusive of the surficial rocks the formations present range in age from Carboniferous to probably lower Tertiary. Oil and gas possibilities of promise seem to be confined to the Cretaceous rocks. Earth stresses of intensity great enough to fold and tilt the rocks appreciably from their originally horizontal attitude were developed in this region during Paleozoic or later time only after the end of the Cretaceous period.

Summary descriptions of the geologic formations, arranged in their proper sequence, are given.

It is believed that the sandstones in at least the upper part of the Kootenai formation, closely associated with the overlying petroliferous rocks in the lower part of the Colorado, offer a possibility of being productive of oil or gas. The Colorado shale seems to be of first importance as a possible source of oil and gas in northwestern Montana and according to present information is the only promising source known. In the area here discussed the lower part of this shale was found to be petroliferous in every extensive exposure in a belt extending about 35 miles from north to south across the area between Deep Creek and Sun River. It contains bituminous shale, which yields oil on distillation, and soft maltha or natural tar in crevices of fractured limestone, which very probably is a residuum from the evaporation of petroleum. The evidence seems fairly conclusive that this shale offers a source for petroleum that may have accumulated in commercially valuable quantities either in the Colorado or in the sandy portions of the Kootenai and Virgelle sandstone in immediate contact with it.

The area described in this report can be readily divided into two large structural units which differ greatly in the degree to which the strata have been deformed. A slightly curving line, in general parallel to the mountain front, extending northward a distance of nearly 60 miles, would mark a sharp transition from an area on the east in which the

beds are nearly horizontal to an area on the west in which the rocks have been severely compressed into folds and broken by faulting.

In the area of nearly horizontal rocks there are six large anticlines whose structure is probably continuous in depth far enough to form traps in sands in the Virgelle, Colorado, and Kootenai formations. The belt of disturbed rocks in the Cretaceous and Tertiary (?) formations adjacent to the mountains in the Birch Creek-Sun River area is a small part of a large structural province that extends northward far beyond the Canadian boundary into Alberta, a distance exceeding 200 miles, and southward to the valley of Dearborn River.

R. W. STONE.

ENGINEERING.—*Physical and chemical tests on the commercial marbles of the United States.* D. W. KESSLER. Bur. Stand. Tech. Paper No. **123**. Pp. 54, pls. 7. 1919.

This paper is the first report of the Bureau of Standards in connection with an extensive cooperative program for investigating the building stones of the United States. The other government departments participating in the work on different phases of this investigation are the U. S. Geological Survey, Bureau of Mines and Bureau of Public Roads.

This paper comprises the results of strength tests, water absorption, porosity, specific gravity, freezing, thermal expansion, electrical conductivity and chemical tests on 52 different types of marbles produced in this country. The purpose of the work is to determine the relative value of the different types for building purposes and other special uses.

Compressive strength tests were made on specimens in the original condition and on specimens after being soaked in water for two weeks. The strength of the dry specimens gave values ranging from 7850 to 50205 lbs. per sq. in. As a rule the soaked specimens gave lower compressive strengths than the dry, and in a few cases the loss due to soaking was over 25 per cent.

Transverse and tensile strength tests are included and show the strength of the specimens when broken perpendicular and parallel to the bedding planes.

The freezing tests made for this report consisted in determining the loss in weight and strength due to 30 freezings and thawings. While these losses were considerable in most cases, some samples showed practically no loss and occasionally a gain in strength was indicated.

Hence it was decided that 30 freezings are not enough to give a trustworthy indication of the durability of such materials. An apparatus has been installed which automatically shifts the specimens back and forth between a cold chamber and warm chamber at certain intervals. With the use of this apparatus, it is possible to make a great number of freezings which will correspond to several years of exposure to the weather. It is proposed to make extensive weathering tests with this apparatus to determine more definitely the relative effect of frost action on the different marbles as well as other types of building stones.

Electrical resistivity tests were made on a number of different types to determine their relative value as insulators and resistivity under different conditions of moisture. The results show a considerable range of values indicating that there is a choice of marble for use in switch boards and allied purposes.

Measurements of the thermal expansion made on a few samples of marble in this investigation show that this material does not expand at a uniform rate even at ordinary temperatures. As the temperature is increased the rate of expansion increases, hence it is not possible to state a coefficient of expansion for marble that will hold good for any very great range of temperatures. Another peculiarity brought out by these tests was the fact that marble when expanded by heating does not contract to its original dimensions as the temperature is lowered, but retains a part of the increase permanently. A number of successive heatings show the same effect, each adding an increment of length to the specimen.

A few cases of warped marble slabs are illustrated and a discussion is given of the causes which may be instrumental in bringing about this warping.

METALLURGY.—*Aluminum and its light alloys.* Bur. Stand. Cir. No. 76. Pp. 120. 1919.

This circular attempts to give all available information concerning the physical and mechanical properties of aluminum and its light alloys in summarized form. Commercial alloys are described and compared. The corrosion and disintegration of aluminum and its alloys are considered.

The endeavor has been made to reproduce only such data as have passed critical scrutiny. Wherever possible, data and information have been put into the form of tables and curves. A complete bibliography and specifications for aluminum and its light alloys are given.

J. F. MEYER.

METALLURGY.—*The effect of rate of temperature change on the transformations in an alloy steel.* H. SCOTT. Bur. Stand. Sci. Paper No. **335.** Pp. 91–100, figs. 7. 1919.

Cooling curves taken on an air-hardening steel of the high speed tool steel type show two critical points on cooling from 920° C, one occurring at about 750° C. accompanied by the precipitation of the hardening constituent, the carbide, and the other on fast cooling at about 400° C. under which condition the carbide remains in solution as martensite. On cooling at intermediate rates both transformations are observed and the constituents, troostite and martensite, are detected by the microscope. A transformation is observed on the heating curves taken following a fast cooling which is manifested by an evolution of heat ending at about 645° C. and which represents the precipitation of the carbide held in solution by previous rapid cooling. The resolution of the carbide under these conditions occurs at a temperature some 10 to 15° C. higher than after a slow cooling.

The conclusions drawn support the twenty-year-old theory of Le Chatelier that martensite is a solid solution of carbide in alpha iron.

H. S.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY OF WASHINGTON

818TH MEETING

The 818th meeting was held at the Cosmos Club, April 12, 1919, President HUMPHREYS in the chair; 58 persons present. The minutes of the 817th meeting were read in abstract and approved.

The first paper was presented by Mr. WM. BOWIE on *Mapping the United States for military and civil needs*. This paper was illustrated by lantern slides.

The speaker covered the general phases of map making in the United States and showed the steps that were taken in making the surveys and the resulting map, in any area in which no control or maps existed. No details were given in regard to the technical questions involved, although there are many of great interest in connection with the work in the field, in the drafting room, and in the map reproduction plant.

There are many uses to which maps can be put and, in general, there is a map for each of the special uses. Some of the maps are very detailed in character, showing the natural as well as the cultural features and giving accurate contours to show the elevations and configuration of the ground.

It was said by the speaker that about 40 per cent of the United States has been topographically surveyed but that some of this area will have to be resurveyed on account of the improvement in methods and the more exacting demands of map users.

The question before the mapping bureaus to-day is the task involved in making accurate contoured maps over the remaining 60 per cent of the area of the country. Before this can be done efficiently, precise leveling and primary triangulation must be carried into much of the unmapped area. The early completion of the map of the United States would be of great military and civil benefit, as accurate maps are essential from a military standpoint in the defense of the country, and from a civil standpoint it is necessary to have them for the efficient development of industries and commerce.

The speaker said that very accurate maps of large scale should be made along the coasts of the United States for purposes of defense in case of invasion. The war has proved that troops cannot operate effectively without very accurate maps on which a great amount of military detail connected with the movement of troops may be shown. For artillery purposes the maps must be exceedingly accurate, in order that long range firing may be effective.

The speaker discussed the question of whether accurate maps can be made from aeroplanes and expressed the opinion that undoubtedly aeroplane photographs can be used in the revision of existing maps. In many cases where the country is practically flat, aeroplane photographs may be used for original surveys. It is probable that difficulty would be experienced in making contour maps from aeroplane photographs. This would be due to the difficulty of having the camera in a vertical position at the time the photograph was taken and on account of the condition which would make it impossible to do accurate contouring when the contour interval is small. Undoubtedly the aeroplane will have considerable use in surveying and at present several of the government organizations engaged in mapping are investigating the subject of surveying from aeroplanes.

Discussion.—Capt. Ellis spoke of the German and French maps of eastern France. Mr. J. F. Hayford discussed the possibilities of mapping from aeroplane photographs. Mr. G. K. Burgess spoke of the work of the French in constructing maps for Algeria and Morocco from aerial photographs.

The second paper was by Mr. Oscar S. Adams on *A study of map projections in general* and was also illustrated by lantern slides.

The difficulty encountered in map construction arises from the fact that the earth's surface is ellipsoidal in shape and is consequently non-developable, that is, it cannot be spread out in a plane without some stretching, some tearing, or some folding. The determination of a projection consists in fixing upon some system of lines in the plane that will represent the meridians and parallels upon the earth. An orderly arrangement of these lines, such as to give a one-to-one correspondence between the points on the earth and those upon the plane, is generally expressed in terms of some mathematical formula, and in fact all projections in use can be so stated.

In studying projections there are four main things to be considered. These four considerations are:

(1) The accuracy with which a projection represents the scale along the meridians and parallels.

(2) The accuracy with which it represents areas.

(3) The accuracy with which it represents the shape of the features of the area in question.

(4) The ease with which the projection can be constructed.

The scale of a map in any given direction at any point is the ratio which a short distance measured upon the map bears to the corresponding distance upon the surface of the earth.

The subject of map projections is generally treated under the following subdivisions:

(a) Perspective or geometrical projections. (b) Conical projections. (c) Equivalent or equal area projections. (d) Conformal projections. (e) Azimuthal or zenithal projections.

These classes are not, however, mutually exclusive since a given projection may belong to two or sometimes three of the classes.

The subject of map projections is a very wide one and some of the considerations have their roots extending far into the fertile soil of pure mathematics. A careful working out of the results for any one projection forms a good exercise in the practical application of mathematical knowledge.

Discussion.—This paper was discussed by Messrs. SOSMAN and WM. BOWIE.

Adjournment took place at 9.53 P.M. and was followed by a social hour.

819TH MEETING

The 819th meeting was held at the Cosmos Club, May 10, 1919, President HUMPHREYS in the chair; 40 persons present.

The minutes of the 818th meeting were read in abstract and approved.

The first paper was presented by Mr. F. J. SCHLINK *On the nature of the inherent variability of measuring instruments.*

This paper treats of those characteristics of the performance of an indicating measuring instrument, on account of which the instrument fails to give identical readings for repeated applications of the same value of the quantity being measured. Variable errors introduce serious difficulties, and the obtaining of a high degree of freedom from variability in instrument operation, although it has not until very recently been given any general or systematic consideration, is likely to be very much more important than mere smallness of calibration error. A means of defining the variability of measuring instruments, either indicating or integrating, with respect to random observations in calibration, is illustrated, in which the characteristics of the instrument, as regards dispersion of readings, are set forth by reference to the surface defined by a family of probability curves.

The concepts of resilience and the cyclic state with respect to instrument operation are next introduced and it is shown by experimental results on a typical indicating instrument of considerable mechanical complexity that when once cyclic or regularized operation is set up, the indications lie upon a hysteresis loop which, while defining a zone of uncertainty or variance, is in itself definite and reproducible with high precision, provided that the successive increments of the independent variable are applied aperiodically and in the absence of jarring or vibration, in such manner as to avoid all overshooting of the final reading. This method is directly applicable only in the absence of appreciable transient after-effects in the operation of the instrument.

The causes of instrumental hysteresis may be either elastic or mechanistic; the nature and effect of the latter are illustrated and explained. The type of calibration that would obtain in the absence of friction has been determined by the study of instruments subjected to vigorous jarring and the relation between cyclic and acyclic calibration was thus made evident. An experiment was shown using a crude type of automatic weighing scale which served to demonstrate the determinate nature of the hysteretic lag in the unvibrated, aperiodic condition of

operation, as well as the influence of jarring upon the nature and amount of the lag.

The paper was illustrated by lantern slides.

The paper was discussed by Messrs. C. A. Briggs and W. P. White.

The second paper was presented by Mr. R. L. Sanford on *Magnetic analysis*.

This paper gives a definition of magnetic analysis and briefly discusses the scope of the subject.

It points out that a method which makes possible the testing of steel and steel products without in any way injuring the product gives promise of having very great commercial value.

The very strict correspondence between the magnetic and mechanical properties may serve as the basis for such a non-destructive method of inspecting steel products by comparison with tested samples which thus constitute standards of quality.

The proper interpretation of the results of magnetic analysis requires a full and complete knowledge of the correlations existing between magnetic and other properties of steel. Much remains to be done along this line.

A number of applications of magnetic analysis that give promise of practical value are described. Each type of problem requires an individual solution and there are many types of problems.

It is not by any means to be claimed that magnetic analysis will displace any of the present well established methods of metallography. On the other hand, it bids fair to develop into a powerful tool in the hands of the investigator as well as a rapid and accurate means for the testing of steel and steel products.

The paper was illustrated by lantern slides.

Discussion.—This paper was discussed by Messrs. White, Sosman, C. A. Briggs, Dickinson, Crittenden, Herschel, and Agnew.

Adjournment took place at 9.50 p.m. and was followed by a social hour.

S. J. Mauchly, *Recording Secretary.*

GEOLOGICAL SOCIETY OF WASHINGTON

336TH MEETING

The 336th meeting was held at the Cosmos Club, Wednesday evening, May 7, 1919, President ULRICH presiding, and 173 persons present.

ALFRED H. BROOKS: *Some geologic problems relating to the war in Europe.*

At the outbreak of the war no provision had been made for the use of geologists in any of the belligerent armies. So far as known the British Expeditionary Force was the first to employ geologic officers in determining water supply, and the Germans the first to recognize the need of geologic knowledge in military mining. In the latter field the British soon followed, and under the leadership of Lt. Col. T. EDGEWORTH DAVID carried the geologic work to a much higher degree of refinement than did any of the other armies. Geologic staffs were organized in both the British and German armies early in 1916, and probably at about the same time geology was given some recognition in the Austrian Army. A geologic section was established in the American Expeditionary Force in September, 1917. There were no geologic officers in the French Army during the entire war, though some of the French engineers made use of the science.

The principal applications of geology to military problems are as follows:

(1) The determination of water resources, both underground and surface, at the front and along the line of communication.

(2) The determination of the physical character of soil, subsoil, and bedrock and the presence or absence of underground water with relation to their effect on field works, including trenches, dugouts, and mines.

(3) The distribution, occurrence, and quantity of road metal, ballast, and material for concrete.

(4) The determination of the physical character of soil, and subsoil during wet and dry seasons, with relation to its influence on the movement of large bodies of troops and of artillery and tanks.

Practically all uses of geology fall within the above general classification. It is evident that any engineering project involving extensive excavation may call for geologic knowledge. It is evident too that the sanitation of camps and cantonments must take cognizance of the underground drainage conditions as well as of water supply and surface formations. It has been found that certain geologic conditions by furnishing good electric transmission favor the use of the listening devices which were extensively used during the period of trench warfare. It should be added that one of the important uses of geology in the

American Expeditionary Force was the forecasting of the physical conditions within the enemy's lines.

337TH MEETING

The 337th meeting was held at the Cosmos Club on Wednesday evening, May 14, 1919, President ULRICH presiding, and 58 persons present.

Capt. CHARLES H. LEE: *Experiences in supplying water to our army at the front.*

Drainage areas and general geology with special reference to pervious and impervious rocks were described. The rivers are widely distributed and in many areas springs are a very valuable source of water supply, especially in Northeastern France where the American Expeditionary Force was engaged. The most important are contact springs between limestone and shale. The Paris Basin is an artesian basin, the water being in greensand formations. Illustrations were shown of the various methods used by the engineers to supply the troops with water, including the construction of dams and concrete and wooden tanks, and the transportation of water both by pipe lines, automobile trucks, wagons, and, lastly, by small tanks on men's backs delivered directly to the men in the trenches.

KIRK BRYAN: *Habits of thought of a geologist applied to military problems.*

The speaker related his experience as a private in the Intelligence Section (G-2) of the 5th Army Corps, First American Army, during the St. Mihiel and Argonne-Meuse operations extending from September 12 to November 11, 1918. He referred to the demand for geologic and physiographic information in active military operations and showed examples of such work done under the disadvantageous conditions of war. He pointed out that geologists have a mental limitation which compels them to think along professional lines; they should on this account be placed in such position in an army that this habit of thought will be most useful. One of these places is in the Intelligence Section where studies of the terrane are required and can be most readily circulated.

These studies will be of two types: (1) general papers referring to large areas in the theater of war and sent out from Army Headquarters from time to time; (2) special local reports of enemy defensive areas or of the zone of advance sent out from Army Corps Headquarters immediately previous to an attack. These descriptions should be skilfully prepared on the basis of a genetic study of the physiography but without technical language and accompanied by diagrams, profiles, sketches and, when available, photographs. The object of the reports is to stimulate the imagination and assist in the visualization of the enemy country. Over this country troops must advance and it is too much to expect that the officers of the time, largely drawn from civilian life, should be adepts at the difficult art of visualization from maps. For, however good the maps, visualization is a difficult mental

process even for trained men and accurate skilfully written descriptions are a great aid.

ADOLPH KNOPF: *Present tendencies in geology: metalliferous deposits.* The chief problems and tendencies at the present time in the study of ore deposits are: (1) the reaction against undue dependence on the microscope, whether it be the petrographic or the metallographic microscope; (2) the determination of the influence of pressure and temperature in producing the mineral facies of ore deposits, and as a corollary, the zonal distribution of ore deposits around intrusive centers; (3) the application of physical chemistry to the problems of ore deposition; (4) the reaction against the extreme acceptance of the doctrine of the origin of ore deposits from magmatic waters; (5) the application of physiography to economic geology, especially with reference to the origin of gold, iron, manganese, and nickel deposits as related to the development of peneplains; (6) the bringing of economic geology into closer touch with economics and with the larger social policies of the State; (7) the taking of inventories of the world's chief mineral resources; and (8) the estimation of mineral reserves by improved methods, especially by applying the modern methods of statistical analysis. The war and the problems arising from the war as to the international adjustment of mineral supplies have particularly emphasized the need for detailed information on the world's mineral resources, especially for information of a quantitative character.

RALPH W. STONE, *Secretary.*

SCIENTIFIC NOTES AND NEWS

MATTERS OF SCIENTIFIC INTEREST IN CONGRESS

Since the last report in this JOURNAL[1] Mr. BACHARACH'S bill (H. R. 7785) has been passed by the House of Representatives, and is now in the hands of the Senate Committee on Finance.

The bill as now drawn provides an increase of 15 per cent in the existing duty on chemical glassware, 10 per cent on porcelain ware, 25 per cent on scientific instruments, 40 per cent on surgical and dental instruments; removes optical glass from the free list and places thereon a duty of 45 per cent; and repeals the existing "duty-free provision." It was debated in the House (in session as Committee of the Whole) on August 1 and 2. Mr. Bacharach presented the principal arguments for the bill, emphasizing not only the "revenue," "infant industry," and "cheap foreign labor" arguments which support all protective tariff bills, but also the "key industry" and "foreign propaganda" arguments, which are comparatively new in American tariff discussion. The latter two arguments were scarcely referred to again during the debate. The strongest future foreign competition, according to Mr. Bacharach, is expected to come from Japan, not from Germany. Mr. MOORE, of Ohio, also supported the bill on behalf of glass and porcelain manufacturers in his district. Mr. GRIFFIN, of New York, opposed the bill, asserting that it was "the opening gun in the battle for a general increase of the tariff." Mr. KITCHIN, of North Carolina, also opposed it, arguing in favor of a licensing system instead of a protective tariff. The rest of the debate was essentially political. An amendment to insert "watch crystals, 60 per cent ad valorem" went out on the point of order that the bill related only to chemical and laboratory glassware. Three Democratic amendments to restore existing rates were defeated; likewise an amendment to retain the duty-free provision, in supporting which Mr. Kitchin asserted that the repeal of the duty-free clause would tax college students $900,000 yearly for the benefit of the manufacturers. The division on this amendment, as pointed out by Mr. Kitchin, was on strictly party lines.

Mr. TAYLOR, of Colorado, introduced, on August 14, H. R. 8441: "Authorizing the Secretary of the Interior to make investigations, through the Bureau of Mines, of oil shale to determine the practicability of its utilization as a commercial product." Referred to the Committee on Appropriations. A similar bill was introduced in the Senate on August 4 by Mr. KING (S. 2722).

Mr. FRANCE, of Maryland, has introduced in the Senate a resolu-

[1] This JOURNAL 9: 421. 1919.

tion (S. J. Res. 91) "conveying the thanks of Congress to Dr. JAMES HARRIS ROGERS, of Hyattsville, Maryland, the discoverer of underground and underwater radio." An appropriation of $1,000 is provided for a suitable gold medal. Referred to the Committee on Naval Affairs.

A message from the President on August 21 (H. Doc. 197) transmitted an invitation from the Government of the French Republic to that of the United States to send delegates to a proposed conference at Paris on September 30, 1919, "to consider questions relating to the reorganization of the service of the exchange of meteorological information," with a recommendation from the Secretary of Agriculture that appropriation be made for two delegates to the conference. Referred to the Committee on Appropriations of the Senate, and the Committee on Agriculture of the House.

Hearings have been completed on the Patent Office reform bills.

NOTES

An Agricultural History Society has been organized in Washington "to stimulate interest, promote study and facilitate publication of researches in agricultural history." The officers are: *President*, RODNEY H. TRUE, of the Bureau of Plant Industry; *Vice-President*, WM. J. TRIMBLE, of the North Dakota Agricultural College; *Secretary-Treasurer*, LYMAN CARRIER, of the Bureau of Plant Industry; *Members of Executive Committee*, R. W. KELSEY, of Haverford, Pennsylvania, and O. C. STINE, of the Office of Farm Management.

The Chemical Society of Washington (the local section of the American Chemical Society) held its summer excursion on August 15, going by boat to the smokeless powder plant and the naval proving grounds at Indian Head, Maryland.

The Division of Birds of the National Museum has recently acquired by exchange from the American Museum of Natural History 665 bird skins from Colombia, forming a part of the material upon which Dr. F. M. CHAPMAN based his "Distribution of Bird-life in Colombia," published in 1917.

Dr. C. G. ABBOT, of the Smithsonian Institution, returned from his expedition to South America on July 30.

Dr. D. G. BYERS, of the University of Washington, Seattle, recently a captain in the Chemical Warfare Service in Washington, has been appointed chief of the division of chemistry of the Bureau of Soils.

The Division of Plants of the National Museum has received a collection of about 1300 specimens from Colorado and New England, presented by Dr. S. F. BLAKE, of the Bureau of Plant Industry.

Dr. F. G. COTTRELL has been appointed assistant director of the Bureau of Mines, in charge of the newly organized investigations

branch. The operations branch has been placed in charge of Mr. F. J. Bailey, formerly chief clerk of the Bureau.

Dr. Abraham Jacobi, a non-resident member of the Academy, died at his summer home at Bolton Landing, New York, on July 10, 1919, in his ninetieth year. Dr. Jacobi was born at Hartum, Westfalen, Germany, on May 6, 1830. He came to the United States in 1853, as a result of his participation in the revolution of 1848. His sixty-six years of active medical work in New York City, during which he lectured and taught in several of the medical colleges of that city and contributed voluminously to medical literature, earned him the title of "the father and founder of American pediatrics." He had been a member of the Academy since 1899.

Dr. J. A. Le Clerc resigned on August 31 from the Bureau of Chemistry, U. S. Department of Agriculture, and is now with the Miner-Hillard Milling Company of Wilkes-Barre, Pennsylvania.

Mr. J. J. Skinner, of the Bureau of Plant Industry, has been awarded the Edward Longstreth Medal of Merit by the Franklin Institute of Philadelphia, for his paper on "Soil Aldehydes."

Dr. J. E. Spurr has resigned from the Bureau of Mines, to become editor of the *Engineering and Mining Journal* of New York.

Dr. Joseph B. Umpleby has resigned from the U. S. Geological Survey to accept the position of Director of the School of Engineering Geology of the University of Oklahoma, at Norman, Oklahoma.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 9 OCTOBER 4, 1919 No. 16

BOTANY.—*The anay, a new edible-fruited relative of the avocado.* S. F. BLAKE, Bureau of Plant Industry.

One of the most interesting results of the explorations in search of new and desirable avocados and related fruits, carried on in Central America for several years past by Wilson Popenoe of the Office of Seed and Plant Introduction, is the discovery of the anay. Guided by the reports of natives, Mr. Popenoe first met with the species on September 23, 1916, when two trees were found at the entrance to the Finca El Compromiso, half a mile from Mazatenango, Guatemala, at an elevation of about 365 meters. Other trees were known to the natives in the near-by forest, and were visited by them at the proper season to secure the fruit. The two trees seen by Mr. Popenoe had been left to provide shade for young coffee trees when the forest was cleared. They were about 22 meters high, with the tall and slender trunk bare of branches for a considerable distance, and an open rounded crown. On this occasion Mr. Popenoe, being unable to find a native venturesome enough to climb the trees, had to content himself with pieces of the bark and with some of the fruits, which were lying in profusion on the ground. He also secured leaves from sucker shoots at the base of one tree, but comparison with specimens secured from the same tree on a later trip shows that these belong to some other plant.

The fruits of the anay, which ripen in August and September, are very similar in external appearance to those of certain types

of avocado (*Persea americana*). They are 10 to 15 cm. long, ellipsoid-pyriform, sometimes curved, sometimes pointed at apex, often with sharply defined neck, with the body slightly compressed, and smooth, glossy, purplish black surface. The skin is very thin and membranous, adhering closely to the firm, oily, rather scanty flesh. This is divided into two zones of color, equal in thickness, the outer pale green, the inner greenish cream-color, both being more sharply defined than is ordinarily the case in the cultivated avocado. The flesh has a rich, bland flavor, like that of a very good avocado, but faintly sweetish. The large, obovoid seed, with the pointed end toward the base of the fruit, has a thick, almost fibrous, outer seed coat and a membranous inner one closely including the cotyledons, but not always reaching to their apex. The pubescent plumule lies immediately at the base of the cotyledons, while in the avocado it is located some distance above this point. The fruits fall while still hard, ripening in two or three days, and germinating freely on the ground beneath the parent tree. Most of the specimens found by Mr. Popenoe had been attacked by insects, which tunneled through the seeds.

The notes from which this description of the fruit has been drawn up were made by Mr. Popenoe on his first visit to the trees. On a later visit, on January 17, 1917, a mozo was found who ascended one of the trees by means of a near-by palm and threw down branchlets with leaves, young fruit, and a very few flowers. Study of these shows that the anay is not a *Persea*, as Mr. Popenoe at first supposed, but an undescribed species of the genus *Hufelandia*, which is at once distinguished from the avocado (*Persea americana*) and its near relatives by the fact that the anthers are 2-celled instead of 4-celled.

Since collecting the anay at Mazatenango, on the west coast of Guatemala, Mr. Popenoe has found it at Chamá, on the Río Chisoy in the Usumacinta basin in Alta Verapaz, northeastern Guatemala, at an altitude of about 300 meters, although no specimens were obtained. It is the belief of Mr. Popenoe that the name of the old Maya settlement Anaité, farther north in

the same valley near the ruins of Menché Tinamit and Yaxchilan, has reference to the former abundance of the anay in the same region.

The anay, both in the vicinity of Mazatenango and in the Usumacinta Valley, grows in moist regions at an elevation of only 300 to 365 meters. For this reason Mr. Popenoe believes that it will not succeed in California, but that it may do well in southern Florida. Young trees grown from seeds collected by Mr. Popenoe are now cultivated in the Plant Introduction Garden at Miami, under the Seed and Plant Introduction number 43432, and their future will be watched with much interest. In its native haunts the species was reported by natives to flower in May, but from the specimens collected by Mr. Popenoe it is clear that the flowering season is December and January. The fruit ripens in August and September.

As this species of *Hufelandia* is known throughout its range as anay (pronounced ă-nī,[1] and as it is intended to bear the same name on its introduction into culture in the United States, it may be called

Hufelandia anay Blake, sp. nov.

Large tree, up to about 22 meters high, with thick, reddish brown bark; branchlets stout, angulate, densely griseous or rufescent-puberulous with sordid incurved hairs, at length glabrate; leaves alternate, rather crowded toward the ends of the branches, the blades 13 to 20 cm. long, 7.5 to 10 cm. wide, oval, abruptly short-pointed (acumen about 1 cm. long, obtuse), rounded to cuneate at base, chartaceous, pinnate-veined with 10 to 14 pairs of lateral veins diverging at an angle of about 70°, above green, sordid-puberulous along costa and lateral veins, essentially glabrous on the slightly prominulous-reticulate surface, beneath glaucous, rather sparsely puberulous on the surface with whitish hairs, more densely so on veins with sordid loose hairs, with rather prominent secondary veins and obscure tertiaries; petioles stout, sulcate, sordid-puberulous especially above, 2.5 to 3.5 cm. long; panicles axillary, sordid-puberulous, sparsely branched (at least in fruit) and rather slender, 9 to 15 cm. long (including the 4 to 7 cm. long peduncle); pedicels in young fruit somewhat clavate, about 3 mm. long; perianth sordid-pilosulous on both sides, 2.5 mm. long, the segments subequal, oval, rounded at apex, 1.5 mm. wide; perianth tube extremely short; stamens of series I oblong-elliptic, 1.9

[1] The system of diacritical marks here used is that of Webster's Dictionary.

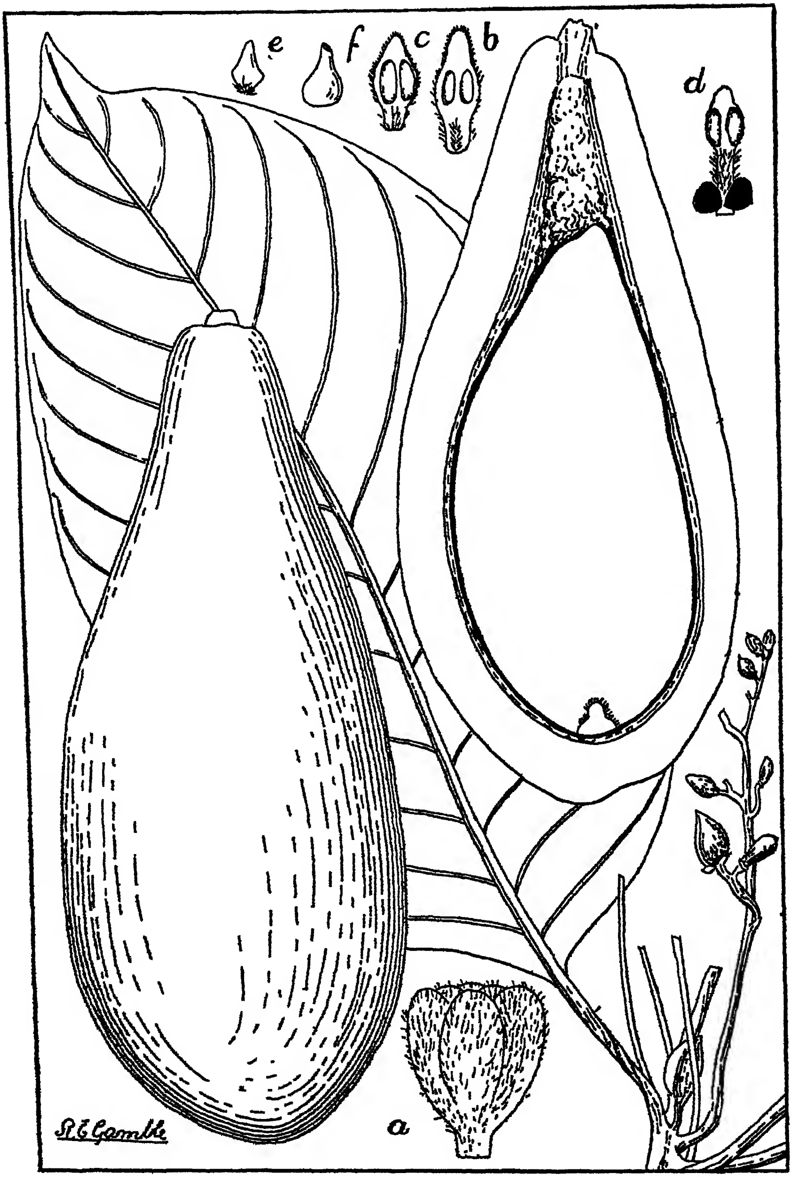


Fig. 1.—*Hufelandia anay*. Leaf, fruit, and longitudinal section through fruit and seed, showing plumule at base of seed, all nearly natural size; *a*, flower; *b*, stamen of series I; *c*, stamen of series II; *d*, stamen of series III, seen from dorsal side; *e*, staminode; *f*, ovary. Details about scale 10.

mm. long, sordid-pilose on back and ciliate to upper level of anther sacs, papillose above, the filaments about 0.4 mm. long, pilose down middle inside, gradually widened into the 2-celled anther, this narrowed into an obtuse appendage about as long as the filament; those of series II similar, 1.5 mm. long, the filaments 0.35 mm. long, pilose on both sides, the 2-celled anther 0.65 mm. long, the triangular obtuse papillose tip 0.5 mm. long; those of series III 2 mm. long, the filaments comparatively slender, 1 mm. long, pilose outside and down midline within, bearing at base two globose sessile basally pilose glands slightly more than half as long as the filament, the oval extrorsely 2-celled anther 1 mm. long (including the 0.3 mm. long obtuse papillose appendage), papillose-pilosulous on back; staminodes triangular, acuminate, 0.9 mm. long, very shortly stipitate, pilose dorsally, glabrous inside; ovary subglobose, narrowed into and about equaling the stout style and obliquely conical stigma; fruit ellipsoid-pyriform, glossy black, thin-skinned, 10 to 15 cm. long; seed very large, obovoid, with thick outer coat; embryo at extreme base of cotyledons.

Type in the U. S. National Herbarium, no. 1011734, collected in loamy soil of tropical forest at Finca Compromiso, Mazatenango, Guatemala, at an altitude of about 365 meters, January 17, 1917, by Wilson Popenoe (no. 754).

Hufelandia anay is easily distinguished from the two species of the genus previously described from Mexico and Central America, *H. mexicana* Mez and *H. costaricensis* Mez Pittier, by the fact that its leaves are glaucous beneath. From *H. pendula* (Swartz) Nees, of the West Indies, which agrees in the glaucescence of its leaves, *H. anay* differs in its larger oval leaves persistently pubescent beneath, its larger sordid-pilosulous flowers, and its much larger fruit.

A related species, collected on the Volcan de Poás in Costa Rica by Mr. Henri Pittier some years ago, may also be described in this connection. The native name of this tree is not known, nor is the nature of its fruit.

Hufelandia ovalis Blake, sp. nov.

Medium-sized tree; branchlets stoutish, subangulate, olive-brown, cinereous-puberulous with appressed hairs, glabrate; leaves alternate, the blades 5.5 to 8 cm. long, 3 to 4.7 cm. wide, oval, acutish or obtuse, at base cuneate to rounded-cuneate, pinnate-veined with 6 to 7 pairs of prominulous lateral veins, thick-pergamentaceous, above dull green or slightly lucid, prominulous-reticulate, rather sparsely pilosulous with loose whitish hairs, glabrescent at maturity, beneath glaucous, finely prominulous-reticulate, pilosulous with loose, curved, whitish hairs, along the veins more densely sordid-pilosulous; petioles stout, flattish, sordid-pilosulous, 7 to 11 mm. long; peduncles axillary, loosely sordid-pilosulous, 2.5 to 3.5 cm. long; panicles ovoid, dense, shorter

than the leaves, sordidly tomentose-pilosulous, 1.8 to 2.5 cm. long, 1.5 to 3 cm. wide; pedicels 1 to 1.5 mm. long; perianth 2.5 mm. long, soon deciduous, sordidly pilosulous-tomentulose both sides, the tube obscure, the segments subequal, oval, rounded at tip; stamens of series I 2.2 mm. long, the stout filaments 0.8 mm. long, pilose on back and down midline within, the 2-celled ovate eciliate sparsely papillose anthers 1 mm. long, the quadrate obtuse appendage 0.3 mm. long; those of series II similar, 2.4 mm. long (filament 1 mm., anther 1.1 mm., appendage 0.3 mm.); those of series III 2.2 mm. long, the filaments slender, pilose, 1 mm. long, bearing at base 2 cordate-globose short-stipitate glands essentially as long, the extrorsely 2-celled anther 0.8 mm. long, the thick truncate appendage 0.4 mm. long; staminodes 1.1 mm. long, deltoid, acute, pilose on back and on the short, broad stipe; ovary glabrous, globose-ovoid, 1.5 mm. long, narrowed into the 0.5 mm. long style and oblique stigma.

Type in the U. S. National Herbarium, no. 578438, collected on the Volcan de Poás, Costa Rica, altitude 2300 meters, March 31, 1907, by H. Pittier (no. 2040).

Hufelandia ovalis is related to *H. anay* and *H. pendula*. From the former it may be easily distinguished by its much smaller, finely prominulous-reticulate leaves, its longer filaments, and its larger floral glands. From the latter it differs in its thicker more finely reticulate leaves, its dense ovoid panicle, and its longer filaments.

GENETICS.—*On Mendelian inheritance in crosses between mass-mutating and non-mass-mutating strains of* Oenothera pratincola.[1] FRIEDA COBB and H. H. BARTLETT.

A former paper[2] has dealt with the striking difference in mutability between certain strains of *Oenothera pratincola* that are morphologically identical. The strains in question were derived from seeds of wild plants collected in 1912 at Lexington, Kentucky. Several of them, typified by the strain designated as Lexington C, show only a moderate degree of mutability.

[1] Papers from the Department of Botany of the University of Michigan, No. 160. This paper is published as presented at the Pittsburgh (1917) meeting of the Botanical Society of America. It has been lying in manuscript since the fall of 1917. The data upon which it is based have since been greatly amplified. The new results are based upon much larger cultures and verify those here presented, but are not yet ready for publication. A preliminary abstract has appeared elsewhere. (Proc. Mich. Acad. Sci. 1918: 151. 1919.)

[2] BARTLETT, H. H. *Mass mutation in* Oenothera pratincola. Bot. Gaz. 60: 425–456. 1915.

They have given rise to a number of interesting mutations, one of which, mut. *nummularia*, is especially conspicuous in the young seedling stage because of its orbicular leaves, and was on that account the first to receive intensive study.[3] In general, the mutations of the relatively stable strains belong to two types, (a) those that come true when self-pollinated and show matroclinic inheritance in crosses with the specific type (*e. g.*, mut. *nummularia*) and, (b) those that split in every generation into the mutational type and the specific type, regardless of whether they are self-pollinated or pollinated by the specific type. The latter are similar to *Oenothera stenomeres* mut. *lasiopetala*[4] and to certain mutations from *Oenothera Lamarckiana* described by de Vries.[5]

A strain of *Oenothera pratincola* differing from all the rest has been designated as Lexington E. It has given rise to some, but not all, of the mutations thrown by the other strains, and in addition it has produced in large numbers a series of characteristic mutations having certain characters in common that are not met with among the mutations of the other strains. These characters are revoluteness of the leaves and the possession of a peculiar subterminal filiform appendage on the lower surface of the leaf, into which the midvein is diverted. All of the characteristic mutations of the mass-mutant strain, Lexington E, come true, whether self-pollinated or pollinated by the f. *typica* of strain E. To be more precise, they come true in the sense that they do not revert, in part of each generation, to f. *typica*, although they may be very highly mutable, and give rise to other members of the revolute-leaved series of mutations.

In brief, there are relatively stable strains of *Oenothera pratincola*, such as Lexington C, which throw small numbers of flat-leaved mutations belonging to several kinds, one of the most

[3] BARTLETT, H. H. *Additional evidence of mutation in* Oenothera. Bot. Gaz. 59: 81–123. 1915.

[4] BARTLETT, H. H. *The mutations of* Oenothera stenomeres. Amer. Journ. Bot. 2: 100–109. 1915.

[5] DE VRIES, HUGO. *New dimorphic mutants of the Oenotheras.* Bot. Gaz. 62: 249–280. 1916.

characteristic being mut. *nummularia*. There is also one highly mutable (mass-mutant) strain, Lexington E, which gives rise in large numbers to several kinds of revolute-leaved mutations, produced by no other strain. The most notable of them is mut. *formosa*. Lexington E also throws some of the flat-leaved mutations which are more commonly met with in the other strains, but mut. *nummularia* has never appeared among them.

All experiments thus far made with the revolute-leaved mutations indicate that in crosses with f. *typica* of the same strain inheritance is matroclinic. Their behavior affords a parallel to that of *Oenothera Reynoldsii* and its mutations.[6] Because of their markedly dissimilar mutation phenomena, it was suspected that the rule of matroclinic inheritance might not hold in crosses between strains C and E. In order to test this point, and also to determine the effect of crossing on the mutability of the strains, the following pollinations were made in 1915:

f. *typica* C × f. *typica* E (unsuccessful).
f. *typical* E × f. *typica* C (unsuccessful).
f. *typica C* × mut. *formosa* E (successful).
mut. *formosa* E × f. *typica* C (unsuccessful).
mut. *latifolia* C × mut. *formosa* E (unsuccessful).
mut. *formosa* E × mut. *latifolia* C (successful).
mut. *gynocrates* C × mut. *formosa* E (successful).
mut. *formosa* E × mut. *gynocrates* C (successful).

Unfortunately, as indicated above, several of the more important crosses were unsuccessfully attempted. An effort to repeat them in 1916 failed because of unfavorable weather conditions. No significance is attached to the failures, since it is believed that all of the forms are fertile *inter se*. Probably the next repetition of the crosses, under favorable conditions, will result in a complete series. In any event the delay in rounding out the experiment must be considerable, and since important results have already been obtained we have determined to present the data at hand.

[6] La Rue, Carl D., and Bartlett, H. H. *Matroclinic inheritance in mutation crosses of* Oenothera Reynoldsii. Amer. Journ. Bot. 4: 119–144. 1917.

A NEW CASE OF MENDELIAN INHERITANCE IN OENOTHERA.

Perhaps the most authentic case of Mendelian inheritance in the group of the evening-primroses is that afforded by *Oenothera brevistylis*, which acts as a recessive in crosses with its parent species, *Oe. Lamarckiana*, with other mutations from *Oe. Lamarckiana*, and even with unrelated species.[7,8] Another instance is that of the dwarf mutation from *Oe. gigas*.[9] Both of these cases have been discovered by de Vries. Heribert-Nilsson[10] has presented an elaborate Mendelian explanation of Oenothera genetics which is chiefly remarkable for its failure to square with the facts. It is based upon a supposed monohybrid segregation in crosses between red- and white-nerved races of *Oe. Lamarckiana*. He failed to find dominant homozygotes, and the evidence of Mendelian behavior is anything but clear. Gates[11] has argued that *Oenothera rubricalyx* acts as a Mendelian dominant in crosses with *Oe. rubrinervis*, but the question is in controversy between Gates and Shull[12] and cannot for the present be regarded as settled. It is obvious that the whole subject of Mendelian inheritance in Oenothera needs further investigation.

Our data deal with the crosses of mut. *formosa* E, pollinated by two of the flat-leaved mutations of the C strain. The former is the most fertile and vigorous of the revolute-leaved mutations.

[7] DE VRIES, HUGO. *Die Mutations-Theorie.* 1: 223; 2: 151–179, 429.

[8] DAVIS, B. M. *The segregation of* Oenothera brevistylis *from crosses with* Oe. Lamarckiana. Genetics 3: 501–533. 1918.

[9] DE VRIES, HUGO. Oenothera gigas nanella, *a Mendelian mutant.* Bot. Gaz. 60: 337–345. 1915.

[10] HERIBERT-NILSSON, N. *Die Variabilitat der* Oenothera Lamarckiana *und das Problem der Mutation.* Zeitschr. fur ind. Abst. Vererb. 8: 89–231. 1912.

HERIBERT-NILSSON, N. *Die Spaltungsercheinungen der* Oenothera Lamarckiana. Lunds Universitets Arsskrift. N. F., Avd. 2, 12: no. 1. pp. 132. 1915.

[11] GATES, R. R. *The mutation factor in evolution.* London, 1915 (Gives full references to the original papers dealing with *Oenothera rubricalyx*.)

[12] SHULL, G. H. *A peculiar negative correlation in* Oenothera *hybrids* Journ. Genet. 4: 83–102. 1914.

GATES, R. R. *On the origin and behavior of* Oenothera rubricalyx. Journ. Genet. 4: 353–360. 1915.

GATES, R. R. *On successive duplicate mutations.* Biol. Bull. 29: 204–220. 1915.

It has been described and figured elsewhere (see footnote 2). The flat-leaved mutations of strain C were mut. *latifolia* and mut. *gynocrates*. The former, not infrequently produced by both strains C and E, gives dimorphic progenies containing mut. *latifolia* and f. *typica*. It, also, has already been described and figured.[13] Mut. *gynocrates* comes true from seed. It is not one of the better known mutations, but was used in the experiments because it happened to be in flower when the crosses were made, and seemed, in spite of its dwarf habit, to be a form of considerable vigor.

Both mut. *latifolia* and mut. *gynocrates* have pollen that is equivalent to that of the particular f. *typica* from which they are derived. In view of the failure of the crosses in which the pollen of f. *typica* C was used, it is especially important for the reader to understand the basis for this conclusion, which is true not only for these particular mutations, but for all others except those that appear to be tetraploid or triploid. All the progenies thus far grown from self-pollinated mut. *latifolia* have been dimorphic, consisting of f. *typica* and mut. *latifolia*. The f. *typica* from the dimorphic progenies breeds true, whereas the mutation continues to split, in every generation. When mut. *latifolia* is crossed with pollen of f. *typica*, the F_1 generation is quite like that resulting from self-pollination. Moreover, when pollen of the mutation is used in crosses with f. *typica* or its other mutations, nothing is obtained in the F_1 or subsequent generations which would not have resulted from self-pollination. Double reciprocal crosses still further substantiate the identity of the pollen of mut. *latifolia* with that of f. *typica*.

The same facts apply to mut. *formosa*, except that its progenies do not contain f. *typica*. It shows the same matroclinic inheritance in crosses with other forms belonging to the E strain. Culture records bearing out the conclusions that have been made with regard to the equivalence of its pollen with that of f. *typica* E and mut. *latifolia* E are given in table 1. The records are in

[13] TUPPER, W. W., and BARTLETT, H. H. *The relation of mutational characters to cell size.* Genetics 3: 93–106. 1918.

part new, in part assembled from a former publication (see footnote 2). The points brought out are:

(a) The essential similarity of the progenies of mut. *formosa*, when used as a seed parent, regardless of whether the pollen is derived from f. *typica*, mut. *latifolia*, or mut. *formosa*.

(b) The failure of pollen from different sources to influence the composition of progenies from the same f. *typica* seed-parent.

(c) The stability in the F_2 generation of f. *typica* derived from the cross f. *typica* × mut. *formosa*. It will indeed be observed that mut. *formosa* occurs in the progeny, but in no greater numbers than one might expect as a result of mutation.

TABLE 1

CULTURE RECORDS ILLUSTRATING THE EQUIVALENCE OF THE POLLEN IN F. *typica*, MUT *latifolia*, AND MUT. *formosa*, WHEN THESE ARE *All* DERIVED FROM THE STRAIN OF *Oenothera pratincola* DESIGNATED AS LEXINGTON E

Parent	Seeds	Total plants	Classified	f *typica*	mut *formosa*	mut *albicans*	mut *revoluta*	mut *sulcata*	Other muts.
typica[b]	1477	1036	All	266	10	57	54	644	5
typica[b] × *formosa*[c]	246	133	All	7	0	1	0	121	4
formosa[c]	177	146	All	0	130	2	0	14	0
formosa[d]	1371	1082	All	0	883	1	4	194	0
formosa[e] (1916)	334	120	All	0	93	0	1	26	0
formosa[e] (1917)	236	195	96	0	46	0	0	40	0
formosa[f]	518	100	49	0	0	0	0	0	0
formosa[d] × *typica*[a]	365	309	All	0	218	0	0	91	0
formosa[c] × *typica*[b]	333	177	All	0	151	0	3	23	0
typica[g] from (*typica*[b] × *formosa*[c])	446	262	All	103	3	5	2	149	0
formosa[f] × *latifolia*[h]	46	36	All	0	34	0	1	1	0

[a] Lex. E–5–217 *typica*. [b] Lex. E–5–229 *typica*. [c] Lex. E–5–206 *formosa*. [d] Lex. E–5–199 *formosa*. [e] Lex. E–5–199–28 *formosa*. [f] Lex. E–5–199–58 *formosa*. [g] Lex. E–5–(229 *typica* × 206 *formosa*)–7 *typica*. [h] Lex. E–36–41 *latifolia*.

For the pedigrees of all of these plants, consult Bot. Gaz. 60: 425–456. 1915.

In table 2 are presented the data in regard to the F_1 generation of the crosses between strains E and C, with mut. *formosa* as the pistillate parent. Further crosses are being made, but

TABLE 2

F₁ PROGENIES OF CROSSES BETWEEN STRAINS E AND C, OF WHICH MUT. *formosa* WAS THE PISTILLATE PARENT

Parentage[a]	Seeds	Plants	f. *typica* normal	f. *typica* defective	f. *grisea*	f. *dimorpha*	Other muts.	Died
formosa E × *latifolia* C	358	209	90	30	11	72	1	5
formosa E × *gynocrates* C	190	97	41	26	1	10	2	17

[a] Culture number of the individual of mut. *formosa* used in both crosses, Lexington E–5–199–28.

Culture number of mut. *latifolia*, Lexington C–22–13–87; of mut. *gynocrates*, Lex. C–52–2–13.

there is no doubt, from the evidence at hand, that the flatness of the leaves in the C strain, but not in the E strain, acts as a dominant in crosses with the revolute mutations, when the latter enter into the cross as the female parent. When mut. *formosa* is pollinated by any form belonging to strain C, a diversified progeny is obtained, but all of the individuals have flat leaves. It will be seen by reference to table 1 that self-pollinated mut. *formosa* itself gives a highly diversified progeny, consisting of mut. *formosa*, mut. *albicans*, mut. *revoluta*, and mut. *setacea*. The three latter are interpreted as secondary mutations from the former. If one were to picture a progeny containing all of these revolute-leaved mutations, with their leaves flattened out, but with their other characters unaffected, the progeny of the cross in question (mut. *formosa* E × any form of strain C) would be partially depicted. Since f. *typica* is represented in such a progeny, it is considered to be the equivalent of mut. *formosa*. The other equivalents, or analogues, are not well known as yet, since it has been impossible thus far to obtain seeds from them. One of them, however, f. *grisea*, is assumed to be the equivalent of mut. *albicans* or mut. *revoluta*, and another, f. *dimorpha*, the most abundant of all, the equivalent of mut. *setacea*, Mut. *setacea* is not only the most abundant of the revolute forms, as they occur as secondary mutations in the progeny of mut. *formosa*, but it

also has a very distinctive habit that would enable it to be equated with the corresponding flat-leaved form. Its lower stem leaves, and the leaves of branches that do not bear inflorescences, are very narrowly linear, and exceedingly small. The leaves and leaf-like bracts of the upper portion of the stem, and of the inflorescence-bearing branches, are two or three times as broad, and much longer, giving an effect to the plants as though the flowering branches were all bud-sports on a plant of an entirely different sort. The dimorphic foliage of mut. *setacea* is well represented in a former paper (see footnote 2). F. *dimorpha* has exactly the same characteristic, the leaves being flat instead of revolute, but showing the same well-marked dimorphism. Nevertheless, after having equated mut. *formosa* with f. *typica*, mut. *albicans*(?) with f. *grisea*, and mut. *setacea* with f. *dimorpha*, there are still difficulties in the way of classifying the flat-leaved hybrid progeny. Each form shows far more variation than is customarily encountered in an Oenothera progeny.

In mut. *formosa* there is considerable variation in the development of the leaf blade, in addition to the revoluteness. If a leaf were flattened out, if would not be as broad as a corresponding leaf of f. *typica*. Moreover it would show a markedly irregular development of tissue. The flattening that takes place as a result of hybridization with strain C leaves the weaker plants with irregularly developed blades, although the stronger plants are in every respect fine f. *typica*. The variation with regard to blade development within each distinguishable form renders the cultures difficult to classify. Some of the plants that must be referred to f. *typica*, and that prove to act like f. *typica* in heredity, are much smaller and weaker than is commonly the case. It is generally when the plants are young that the imperfect development of leaf blades is obvious. As a plant becomes older, the leaves of the new growth are successively more and more normal, until at length it will pass a cursory examination as typical in every way. The smaller and weaker plants often bear branches as strong and robust as those of the best-developed *typica*. In a number of cases these branches have been so strik-

ingly different from the rest of the plant as to look exactly like bud sports. On the whole, it is impossible to draw any sharp line between the various phases of f. *typica*, although in table 2 a wholly arbitrary division into "normal f. *typica*" and "defective f. *typica*" has been made. The variations appear to be somatic, and highly subject to environmental conditions. Our hypothesis is that the freely segregating factor for flatness, introduced by the β gamete of strain C, only suffices to insure normal blade development under the most favorable environmental conditions.

TABLE 3

ANALYSIS OF F_2 SEEDLING CULTURES GROWN FROM NORMAL *typica* PARENTS BELONGING TO THE F_1 PROGENY OF THE CROSS MUT. *formosa* E × MUT. *latifolia* C, (LEXINGTON E-5-199-28 × C-22-13-87). AS SHOWN IN TABLE 4, ALL BUT AN INSIGNIFICANT NUMBER OF THE FLAT-LEAVED PLANTS WERE f. *typica*, AND THE REVOLUTE-LEAVED ONES WERE MUT. *formosa*

Parent	Seeds planted	Total plants	Flat-leaved	Revolute-leaved	Ratio
F_1 No. 4	932	315	238	77	756 : 244
	336	203	154	49	759 : 241
	1353	620	460	160	742 : 258
	1050	57	46	11	807 : 193
	3671	1195	898	297	752 : 248
F_1 No. 162	940	217	155	62	714 : 286
	291	246	187	59	760 : 240
	6279	4392	3258[a]	1134	742 : 258
	600	48	33	15	688 : 312
	8110	4903	3633	1270	741 : 259
F_1 No. 190	640	60	50	10	833 : 167
	954	85	64	21	753 : 247
	1594	145	114	31	786 : 214
F_1 No. 204	807	92	69	23	750 : 250
	1400	57	45	12	789 : 211
	2207	149	114	35	765 : 235
Grand total	15582	6392	4759	1633	744 : 256

[a] Four plants of this culture were mut. *nummularia*.

TABLE 4

ANALYSIS OF F_2 CULTURES GROWN TO MATURITY FROM THE SAME PARENT PLANTS AS THE SEEDLING CULTURES OF TABLE 3

Parent	Seeds planted	Total plants	Grown to maturity	f. *typica*	mut. *nummularia*	Other flat-leaved types	mut *formosa*	Ratio
F_1 No. 4	932	315	315	238	0	0	77	756 : 244
	336	203	200	154	0	0	46	770 : 230
	1268	518	515	392	0	0	123	761 : 239
F_1 No. 162	940	217	207	143	2	1	61	705 : 295
	291	246	239	178	1	5	55	770 : 230
	1231	463	446	321	3	6	116	740 : 260
F_1 No. 190	954	85	85	64	0	0	21	753 : 247
F_1 No. 204	807	92	90	62	1	4	23	745 : 255
Grand total	4260	1158	1136	839	4	10	283	751 : 249

TABLE 5

ANALYSIS OF F_2 CULTURES GROWN FROM DEFECTIVE *typica* PARENTS BELONGING TO THE F_1 PROGENY OF THE CROSS MUT. *formosa* E × MUT. *latifolia* C (LEXINGTON E-5-199-28 × C-22-13-87). IN SHARP CONTRAST WITH THE NORMAL PROGENIES FROM NORMAL PARENTS (RECORDED IN TABLES 3 AND 4) THE PROGENIESFROM DEFECTIVE *typica* PLANTS CONSIST LARGELY OF DEFECTIVE PLANTS. NORMAL BUD SPORTS ON DEFECTIVE PLANTS, HOWEVER, GIVE RISE TO NORMAL OFFSPRING ONLY

Parent	Seeds planted	Total plants	Retained and classified	f. *typica*		mut. *formosa*		Other types
				(normal)	(defective)	(normal)	(defective)	
F_1, No. 30 defective	648	56	51	8	34	6	3	0
F_1, No. 31a defective	741	175	167	96	27	39	3	2
F_1 No. 31b normal bud sport	617	40	40	29	0	11	0	0
F_1, No. 39a defective	648[a]	126	126	17	96	13[a]	0	0
	446	165	129	4	88	1	36	0
F_1, No. 39b, normal bud sport	1008	100	96	67	0	29	0	0

[a] This one culture was classified in the seedling stage, which fact probably accounts for the failure to distinguish the class designated as "defective mut. *formosa*." The other cultures were all analyzed at maturity.

Tables 3 and 4 present the data showing segregation into f. *typica* and mut. *formosa* in the F_2 generation grown from four self-pollinated *typica* individuals of the cross mut. *formosa* E × mut. *latifolia* C. In table 3, which is based upon the classification of seedlings, the only distinction is between flat-leaved individuals (mostly f. *typica*) and revolute-leaved (mostly mut. *formosa*). The difference between the two types of leaves is perfectly clear in very young seedlings, though the different revolute-leaved mutations are not easily distinguished from one another, nor some of the flat-leaved mutations from f. *typica*, when very young. The cultures were too large to be carried to maturity as a whole, but the seedling classification was verified by growing to maturity a sufficiently large number of the plants.

Table 4, based upon the plants which were under observation throughout the entire life cycle, shows that there was no significant error in the classification of table 3. The revolute-leaved plants were all correctly identified as mut. *formosa*, and among the flat-leaved plants there was only a negligible proportion of mutations. The ratio of flat to revolute conforms to the simple 3 : 1 Mendelian ratio. The deviations from expectation are very slight, and fall on both sides of the theoretical ratio. The total progeny of each one of the four parents is in quite or almost as good agreement with expectation as is the sum of all four progenies. The total of 6,392 plants, from four parents, gives the ratio 744 : 256, in unusually good accord with the expected ratio 750 : 250.

The reader will notice that the mean germination is only 41 per cent, and that although the germination of the several cultures varies from 4 per cent to 84 per cent, the ratio is nevertheless not seriously disturbed. The probability is therefore great that we are dealing with a case of simple Mendelian inheritance, uncomplicated by selective elimination of zygotes. Incidentally, the results should tend to reassure anyone who may have feared that the work with Oenothera is in general unreliable, on account of the low germinations frequently recorded.

It has already been noted that some of the plants resulting from the cross between strains E and C were characterized by defective leaf development, and that some defective *typica* individuals bore normal branches, which had every appearance of being bud sports. In two such cases separate progenies were grown from seeds of the normal and defective portions of the same plant, with the very striking results summarized in table 5. The progenies contain only normal plants if derived from seeds borne on the normal bud sport, but if derived from seeds of the defective part of the plant, they contain a considerable proportion of plants classified as defective f. *typica*. The cultures are large enough to afford conclusive evidence that whatever the change may be that results in the production of normal from defective f. *typica*, the change is one that may come about in the somatic cells, and, once having come about, is permanent.

As a final proof of the Mendelian nature of the segregation indicated by the 3 : 1 ratio in the F_2 generation, F_3 progenies have been grown from a large number of self-pollinated normal *typica* individuals, in order to demonstrate the existence of homozygous and heterozygous dominants in the ratio 1 : 2 in the F_2 generation. The results are not included in this paper for the reason that they are still being added to and it does not seem desirable to publish only a portion of the data. However, it may be stated that not only do the expected classes occur in the correct ratio in the F_2 generation, but also that the heterozygotes continue to split in the 3 : 1 ratio. The homozygotes of both classes breed true.

Having established the non-Mendelian behavior of the character-pair flatness *vs.* revoluteness within strain E, and having shown that flatness when introduced into strain E by crossing a revolute-leaved type of the latter with strain C, does act in a Mendelian manner, it remains to indicate a possible explanation of the phenomena.

THE HYPOTHESIS OF HETEROGAMETISM.

In accordance with the hypothesis of nonequivalent gametes, which has been decidedly helpful in the interpretation of some

of the genetical peculiarities of Oenothera[14] (see also footnote 6), the male gametes of all of the mutations concerned are thought of as β gametes, and as exactly like the β gametes of the particular f. *typica* from which each mutation was derived. It has been assumed that the appearance of mutations showing matroclinic inheritance in crosses with the parent form is due to changes involving the α gametes, which bear various factors not represented in the β gametes. Such mutations constitute the greater number of those derived from *Oenothera pratincola.* They appear as the result of some modification of the uncompensated factors of the generally female α gametes, and therefore breed true from the first. The generally male β gametes of *Oe. pratincola* have as yet given rise to no mutations that have been detected, but de Vries[15] has found that one of the mutations of *Oenothera biennis* (var. *sulfurea*) shows patroclinic inheritance in crosses with its parent, and is therefore presumably such a mutation. In the heterogametic species of Oenothera, mutations involving the uncompensated factors of the α gametes obviously cannot show Mendelian inheritance. If the α gametes are female, inheritance must be matroclinic.

Since such a conception as that of a series of different mutations, or even of different species, in which the differentiation is brought about wholly by the female gamete, is justifiably foreign to current thought, it may be well to restate some of the grounds for its adoption.

It is a fundamental tenet of Mendelism that in homozygous material the two homologues chromosomes of each pair are equivalent and interchangeable. In heterozygous material one or more chromosomes are modified, but still remain interchangeable with their mates. If the uncompensated characters of the α gamete were borne in one chromosome, the only essential difference that would obtain between the conceptions of heterozygosis and of heterogametism would concern the unequal distribution of α

[14] BARTLETT, H. H. *The status of the Mutation Theory, with especial reference to* Oenothera. Amer. Nat. 50: 513–529. 1916.

[15] DE VRIES, H. *Gruppenweise Artbildung*, p. 298.

and β gametes between the two sexes. In view of the very large number of modifications occurring in the α gamete, however, it seems a more probable hypothesis that the uncompensated characters are borne by a group of chromosomes, which do not segregate freely, but pass together to one daughter cell or the other at the reduction division. Certainly such a hypothesis is useful in the interpretation of Oenothera genetics. The phenomena of matroclinic inheritance are clearly orderly enough in their own way, but are just as clearly non-Mendelian. As Shull (see footnote 11) has said: "Fundamental difficulties are encountered whenever attempts are made to apply to the Oenotheras rules of genetic behavior which are readily demonstrated in other groups of organisms. Equal confusion has arisen by the application of genetic experiences with the Oenotheras to species in which typical Mendelian phenomena appear. A hereditary mechanism must exist in Oenothera fundamentally different from that which distributes the Mendelian unit-characters."

According to the hypothesis of nonequivalent gametes, the Oenotheras should show Mendelian inheritance in cases where the factors concerned are carried by both α and β gametes. In case the factors are carried by only one kind of gamete, non-Mendelian inheritance must be the rule. The α and β gametes may be conceived of as due to the distribution to the daughter cells at meiosis of a distinctly maternal or distinctly paternal set of chromosomes. In other words, instead of a free segregation of chromosomes taking place, one must assume that the haploid set of chromosomes is reconstituted, as far as the factors peculiar to α and β gametes are concerned, just as it entered into the zygote at fertilization. As for the Mendelian characters, we assume that they are represented by factors carried in a residue of freely segregating chromosomes.

The conception of heterogametism may be reduced to the following series of propositions:

(1) In heterogametic species the zygote normally results from the conjugation of unlike gametes (α and β).

(2) The characteristic portion of each kind of gamete consists of a group of chromosomes that remain in association at meiosis. It is possible that the characteristic portion may consist of one chromosome only.

(3) The α gametes, and probably the β gametes also, carry factors in the characteristic portion that are not duplicated in the homologous portion of the complimentary gamete.

(4) Aside from the chromosomes that determine α and β gametes, the chromosomes of Oenothera are freely segregating, and carry factors for Mendelian characters.

(5) The α gametes are usually female, but may be male; the β gametes, on the contrary, are usually male, but sometimes female.

(6) Mutations occurring in the characteristic portion of either α or β gametes do not make their appearance by Mendelian segregation, and do not subsequently show Mendelian inheritance.

Our studies have led us to conclude that the difference between the mass-mutating and nonmass-mutating strains of *Oenothera pratincola* lies in the freely segregating chromosomes. In Lexington E the factor which determines leaf flatness is associated with the characteristic portion of the α gamete. It is not paired with a similar factor in the β gamete. In Lexington C, on the contrary, there is a paired factor for flatness, associated with one of the freely segregating pairs of chromosomes, and therefore carried by both α and β gametes. In Lexington E, the mutative modification of the unpaired factor for flatness results in the appearance of revolute-leaved mutations, which do not come about as a result of Mendelian segregation. The latter fact is proved by their enormous abundance in certain mass-mutating lines, an abundance far in excess of any Mendelian expectation, and by their matroclinic inheritance in crosses with the parent form.

The several revolute-leaved mutations differ from f. *typica* not only in the leaves, but in characters involving other organs also, the degree of the difference depending upon the extent of the mutative modification undergone by the α gamete. Whereas the production of all of the revolute-leaved mutations involves

one modification in common, there are additional modifications in the cases of all except mut. *formosa* which are peculiar to each mutation.

If the α gamete of Lexington C were to undergo exactly the same modification that in Lexington E brings about the production of a particular revolute-leaved mutation, the effect, as far as revoluteness is concerned, would be nullified by the factor pair for flatness in one of the pairs of freely segregating chromosomes. This factor pair has not yet become spontaneously heterozygous, and consequently no other strain except Lexington E has thrown revolute-leaved mutations.

Let α represent the nondissociating, characteristic portion of the α gamete, bearing a factor for flatness, and susceptible of mutative modification to α', in which the factor for flatness is inoperative. Then using the usual Mendelian notation for the freely segregating factor pair for flatness (FF = homozygous flat; ff = homozygous revolute) the constitution, phaenotype, and behavior of the various forms and hybrids involved in our experiments would be as follows:

f. typica C, mut. latifolia C, mut. gynocrates C,	$\alpha\beta$FF,	flat, and, with respect to this character, immutable.
f. typica E,	$\alpha\beta$ff,	flat, mutable.
mut. formosa E,	$\alpha'\beta$ff,	revolute.
typica E × formosa E,	$\alpha\beta$ff,	flat, mutable.
formosa E × typica E,	$\alpha'\beta$ff,	revolute, breeding true with respect to this character.
typica C × formosa E, F_1,	$\alpha\beta$Ff,	flat, segregating with respect to mutability.
	1 $\alpha\beta$FF,	flat, immutable, breeding true.
typica C × formosa E, F_2,	2 $\alpha\beta$Ff,	flat, continuing the segregation of the F_1.
	1 $\alpha\beta$ff,	flat, mutable, otherwise breeding true.
formosa E × latifolia C, F_1	$\alpha'\beta$Ff,	flat, segregating with respect to revoluteness.
	1 $\alpha'\beta$FF,	flat, non-segregating.
formosa E × latifolia C, F_2	2 $\alpha'\beta$Ff	flat, continuing the segregation of the F_1.
	1 $\alpha'\beta$ff	revolute, breeding true.

The actual behavior of the various cultures is very satisfactorily accounted for by means of this formulation. That the revolute-leaved mutations breed true for revoluteness is shown in table 1. In the same table will be found the evidence that the revolute-leaved mutations give matroclinic progenies when crossed with the f. *typica* of the corresponding strain. It is the prevalence of matroclinic inheritance in these mutation crosses that makes a purely Mendelian explanation of their behavior impossible, and that requires the conception of α and β gametes. The data in regard to matroclinic inheritance are in some respects inadequate, and will be amplified as rapidly as possible.

The failure of Lexington C, and the other strains that resemble it, to throw revolute-leaved mutations is attested by the accumulated data for hundreds of cultures, aggregating many thousands of plants. Since the evidence is negative, it would be idle to assemble here the data supporting the conclusion that Lexington E is the only strain in which such mutations occur. The data regarding the mutability of Lexington E are in part published (see footnote 2).

According to the scheme above, one would expect the cross *typica* C × mut. *formosa* to act in a manner quite different from its reciprocal, which we have been considering. Instead of a Mendelian segregation of flat-leaved and revolute-leaved plants in the F_2 generation, one would expect only segregation with regard to the capability of occasionally undergoing the mutative change from flat to revolute. Segregation of this ability would mean that revolute-leaved plants might appear in the the F_2 generation, but, if present, each one would be the result of a separate, individual change; they would not be due to the inheritance of a changed condition, as was the case in the revolute-leaved recessives in the 3 : 1 segregation described.

Such a character, the capability of mutation, is not easy to deal with, since it is impossible to be sure that a particular parent might not show mutability if more of its seeds were germinated. The degree of mutability does not appear to show great uniformity from generation to generation, as may be seen by refer-

TABLE 6.

ANALYSIS OF THE F_1 AND F_2 GENERATIONS OF THE CROSS f. *typica* C × MUT. *formosa* E (LEX. C–22–7–40 *typica* × E–5–199–58 *formosa*), AND OF THE F_1 GENERATION OF THE CROSS MUT. *gynocrates* C × MUT. *formosa* E (LEX. C–52–2–13 × E–5–199–28). THE F_1 GENERATIONS CONSIST OF FLAT-LEAVED TYPES ONLY, AND THE F_2 GENERATIONS SHOW THE EFFECT OF CROSSING ONLY IN THAT THERE IS A SEGREGATION WITH REGARD TO THE CAPABILITY OF GIVING RISE TO REVOLUTE-LEAVED MUTATIONS.

Parentage	Generation	Seeds	Total plants	Retained and classified	f. *typica*	mut. *gynocrates*	Other flat-leaved forms	mut. *formosa*	mut. *albicans*	mut. *revoluta*	mut. *setacea*	rev.-leaved muts. not identified	Total rev.-leaved muts.
typica × *formosa*	F_1	258	87	87	87								0
(*typica* × *formosa*)-6 *typica*	F_2	1018	165	50	50								
		3270	626	50	50								
		4288	791	100	100								0
(*typica* × *formosa*)-51 *typica*	F_2	955	40	40	39	0	0	0		0	1	0	1
		9338	4536	4536	4492	0	4	16	3	6	59	66	140
		10293	4576	4576	4531	0	4	16	3	6	60	66	141
(*typica* × *formosa*)-54 *typica*	F_2	1109	274	200	198		2	0	0	0	0	0	0
		5170	1653	1644	1629		15	2	0	1	3	2	9
		6279	1927	1844	1827		17	2	0	1	3	2	9
gynocrates × *formosa*	F_1	54	26	17	0	8	9						0

ence to an earlier paper (see footnote 2). Some progenies contain many mutations, and mutability would therefore be detected by growing relatively few individuals. Others, on the contrary, contain very few, and a very large progeny indeed would have to be grown in order to feel reasonably sure of the non-mutability of the parent. The authors plan to gather further data bearing on what we may term the "inheritance of mutability" in these crosses between the strains of *Oe. pratincola*. For the present we shall give only the data contained in Table 6. As far as the results go they are in conformity with expectation. The F_1 progenies of crosses between any form of strain C and mut. *formosa* E resemble the C parent, in that the leaves are all flat. In the F_2 we may or may not detect mutations, since they may occur only among one-quarter of the progeny, those having the factorial composition $\alpha\beta$ff. It is of course always possible for α gametes to undergo mutative modification to the condition determining revoluteness, but the mutative modification, if it occurs, is masked in plants carrying the factor F, either from one or both parents (*i. e.*, in 3 out of 4 F_2 plants). In case the plant has the constitution $\alpha\beta$FF or $\alpha\beta$Ff it can never show revoluteness; however the α gametes may become modified.

THE PRODUCTION OF MUT. NUMMULARIA.

One especially interesting fact is that strain E after having been crossed with strain C gives rise to mut. *nummularia*. Under ordinary circumstances it never does so. Similar phenomena are sometimes viewed as due to metacliny. Metacliny, a term first used by de Vries,[16] may be explained in the terms of the $\alpha\beta$ hypothesis as follows: Although most female gametes are α, and most male gametes are β, there are exceptions to both rules, so that occasionally identical zygotes result from reversed fertilizations, the majority of the zygotes being of the constitution $\alpha\beta$, and only a few $\beta\alpha$. Cases of this sort have been described by La Rue and Bartlett. Among the mutation crosses of *Oe. Reynoldsii*. The production of mut. *nummularia* by

[16] DE VRIES, H. *Gruppenweise Artbildung*, pp. 308–310.

strain E, however, is not explainable by any such hypothesis. We have shown that the reciprocal crosses between strains C and E have a different factorial composition, and do not behave at all alike. To view as due to metacliny the occurrence of mut. *nummularia* in the cross E × C (see table 3) is inconsistent with our explanation of the Mendelian behavior of the character-pair flatness *vs*. revoluteness in the same crosses.

A logical explanation would appear to follow if we assume that the round leaves of mut. *nummularia*, although brought about by a change in the α group of chromosomes (or chromosome) of the female gamete, can come to expression only in the presence of the Mendelian factor F which can be introduced by the male β gamete of strain C. In other words, the round leaves of *nummularia* are due to the modification of α, but can reach expression only in the presence of the mendelian factor F. Just as mut. *formosa* can attain expression only in the *absence* of the factor F, and consequently never occurs in pure strain C, of which the f. *typica* has the composition $\alpha\beta$FF, so mut. *nummularia* attains expression only in the *presence* of the same factor, and is consequently never thrown by strain E, in which the f. *typica* has the composition $\alpha\beta$ff. On crossing the two strains, the α portion of the E gamete shows its potentiality for producing mut. *nummularia* when factor F is present; conversely the α portion of the C gamete shows its potentiality for the production of revolute-leaved mutations when the factor F is removed.

SUMMARY.

I. In *Oenothera pratincola* normal fertilization is assumed to take place by the fusion of two kinds of gametes, which are designated as α and β, respectively. Certain chromosomes of the α gametes carry character determiners which have no counterparts in the β gametes. On account of this unbalanced condition, mutations affecting uncompensated determiners appear at once, and neither in origin nor subsequently in heredity do they display Mendelian behavior.

II. On the basis of the preceding assumption it can be understood why the phenomenon known as mass-mutation should occasionally occur. Mass-mutation is a term descriptive of the origin of mutations in such inordinately large numbers that the cultures show no resemblance to Mendelian segregation.

III. In *Oenothera pratincola* the only mutations which have occurred through mass mutation are a series in which the leaves are revolute instead of flat. These revolute-leaved mutations have appeared in only one strain of the species, to the eye indistinguishable from other strains.

IV. It has been discovered that the difference between the mass-mutant and nonmass-mutant strains is that the latter carry a Mendelian factor determining flatness, in addition to the unbalanced determiner for flatness in the α portion of the α gamete. In the mass-mutating strain there is no Mendelian factor for flatness. The constitutions of the zygotes are therefore $\alpha\beta$ff and $\alpha\beta$FF, respectively, the former mutable with regard to flatness, giving rise to revolute-leaved forms with the constitution $\alpha'\beta$ff.

V. In *Oenothera pratincola* the α gametes are female. Reciprocal crosses are therefore unlike with regard to unbalanced characters (those confined to the α portion of the α gamete), being matroclinic in each case. Reciprocal crosses are alike as far as Mendelian characters are concerned. Therefore:

$\alpha'\beta$ff $\times$ $\alpha\beta$Ff $\longrightarrow$ $\alpha'\beta$Ff, flat-leaved, and heterozygous with regard to the Mendelian factor for flatness, segregating in the F_2 generation in the ratio 1 homozygous flat : 2 heterozygous flat : 1 homozygous revolute.

$\alpha\beta$FF $\times$ $\alpha'\beta$ff $\longrightarrow$ $\alpha\beta$Ff, flat-leaved, and heterozygous with regard to capability for giving rise to mutable stocks, segregating in the F_2 generation in the ratio 1 homozygous dominant, flat, immutable : 2 heterozygous, flat, like the F_1 generation : 1 homozygous recessive, flat only through the α determiner for flatness, and therefore mutable with regard to revoluteness.

VI. The results not only afford one of the best examples of Mendelism in *Oenothera* hitherto adduced, but likewise give an

indication as to when Mendelian behavior, as opposed to matrocliny or patrocliny, is to be expected.

VII. The production of mut. *nummularia,* which is never thrown by the strain which gives rise to revolute-leaved mutations, is shown to be due to mutation in the α portion of the α gamete, but nevertheless dependent for its expression upon the presence of the Mendelian factor F for flatness. It may be recalled that mut. *nummularia* shows matroclinic inheritance in crosses with the parent form, the fact which proves the first part of this proposition.

ANTHROPOLOGY.—*Some general notes on the Fox Indians. Part I. Historical.* TRUMAN MICHELSON, Bureau of American Ethnology.[1]

I have assembled here a number of miscellaneous notes on the Fox Indians. The inclusion of bibliographies is justified on the score that recent writers seem to have been totally ignorant of published sources of information on these Indians.

THE NATIVE NAME FOR "FOXES," AND SYNONYMY

The native name for "Foxes" is Me'ckwA'kī'Ag$^{ki'}$[2] which means "Red-Earths." A good synonymy will be found at the end of the article *Fox* in the *Handbook of American Indians.*[3] To this the following may be added: Meskwa'kīhAg^{i},[4] Meckwa'kīhAg^{i}.[5] Meckwa'kihAg^{i},[6] Meskwa'"kī'A̖g^{i},[7] Meckwa'kī'Ag^{i},[8] Me'ckwA'kī-Ag$^{ki'}$.[9] Musquaquas,[10] Musquakas,[11] Mesquakie,[12] Meskwakis,[13]

[1] Printed with permission of the Secretary of the Smithsonian Institution.
[2] MICHELSON. *Information,* 1917.
[3] Bur. Amer. Ethnol. Bull. 30.
[4] WILLIAM JONES. *Fox Texts,* passim.
[5] JONES. Ibidem, passim.
[6] JONES. Ibidem: 10.7; misprint?
[7] JONES. *Handbook of American Indian Languages,* Pt. 1: 741.
[8] MICHELSON. *Current Anthropological Literature,* 2: 234.
[9] MICHELSON. *Information,* 1917.
[10] *Annals of Iowa,* 1870: 366.
[11] Ibidem, 363.
[12] *Mesquakie Booster.*
[13] *Iowa Journal of History and Politics,* 4: 191.

me sga ki A ki,[14] mah squake ha ke,[15] Mus-quak-kie,[16] Mus-quak-kie-uck,[17] Mesh-kwa-ki-ha-gi,[18] Musquaukee,[19] Muskwakiuk,[20] Mskwạkithak,[21] Red Earth(s),[22] Red-Earths,[23] People of the Red Earth,[24] Red-earth family,[25] de la Terre-Rouge,[26] Wa-go-sha-hugi,[27] Fuchsindianer,[28] UtAgāmi`g,[29] Watagamie,[30] Outhagamis,[31] Ottigaumis.[32]

The Menominee synonym is the equivalent of the Ojibwa one (vide supra), but the exact phonetics are uncertain; the Winnebago synonym means "foxes," but the exact phonetics are uncertain.[33]

In the vicinity of Tama, Iowa (their present location), they are not known as "Foxes," but as "Meskwakies," "Mesquakies," "Tama Indians."[34]

[14] Native name spelt in the current syllabary.

[15] *A collection of Meskwaki Manuscripts*, 1.

[16] J. MORSE's *Report to the Secretary of War*, 122.

[17] Ibidem.

[18] J. F. STEWARD. *Lost Maramech and earliest Chicago*, 1903.

[19] Ibidem.

[20] F. KARSCH-HAAK, *Das gleichgeschlechtliche Leben der Naturvölker*, 1: 328.

[21] Shawnee synonym collected by GATSCHET, of the Bureau of American Ethnology, years ago.

[22] STEWARD. Loc cit. passim; translation of la Potheril apud Blair, *Indian Tribes of the Upper Mississippi and Great Lakes Region.* Vol. 1: passim.

[23] JONES. *Fox Texts*, passim.

[24] STEWARD. Loc. cit.

[25] BLAIR. Loc. cit.

[26] LA POTHERIE. *Histoire de l'Amerique septentrionale.* 1722.

[27] STEWARD. Loc. cit.

[28] F. KARSCH-HAAK. Loc. cit.

[29] JONES. *Handbook of American Indian Languages.* Pt. 1: 741. This is the Ojibway synonym, meaning "People of the Other Shore" (JONES, Loc. cit. and *American Anthropologist*, N. S. 6: 370), or "Those who live on the opposite side" (WARREN, *History of the Ojibways:* 33). PARKMAN's statement (*Half-Century of Conflict*, 1: 333, footnote 1) that "The name Outagamie is Algonkin for a fox. Hence the French called the tribe Renards, and the Americans, Foxes," is echoed by KELLOG, *Wisc. Hist. Soc. Proc.* 1907: 142. This simply betrays ignorance of Algonkin languages. See also my discussion of the early history of the Foxes. The absurd blunder has been repeated by STEWARD, Op. cit. 79.

[30] STEWARD. Loc. cit.

[31] BELTRAMI. *A Pilgrimage*, 2: 169.

[32] Map in J. LONG's *Voyages and Travels.*

[33] MICHELSON. *Information.*

[34] MICHELSON. *Information.*

THE EARLY HISTORY OF FOX INDIANS

The general history of the Fox Indians is extremely well-known.[35] I shall accordingly only try to clear up the beginning of their history. First of all, the *Outitchakouk* are not the Foxes, as is stated in the index to the *Jesuit Relations* (ed. Thwaites).[36] Now we are told: "The Outagamis are of two lineages; those of one family call themselves Renards, and the others are of the Red-earth family."[37] Evidently something of this sort is to be understood by the statement in the *Jesuit Relations*,[38] "The mission of St. marc to the Outagami, where are the ouagoussak, Makoua, makoucoué, Mikissioua." For *ouagoussousak* simply means "foxes."[39] Whether or not a misunderstanding arose by taking the name of a gens as the name of the tribe,[40] the fact remains that some Indian tribes did and do call the Meskwakis by the equivalents of "foxes." Now the *Skenchiohronon* of the *Jesuit Relations* are not the Neuters as is commonly assumed,[41]

[35] A list of the more important papers dealing with this topic is as follows: Articles *Fox* and *Sauk* in *Handbook of American Indians* (Bur. Amer. Ethnol. Bull. 30), H. W. BECKWITH, *The Illinois and Indiana Indians*, 146–162; WARD, *Meskwakia*, Iowa Journ. Hist. Polit. 4: 179–189; WARD, *The Meskwaki people of to-day*, ibidem., 190–219; FERRIS, *The Sauk and Foxes of Franklin and Osage Counties*, Kans. State Hist. Coll. 11: 333–395; PARKMAN, *A half century of conflict*, chapters xii and xiv; J. F. STEWARD, *Lost Maramech and earliest Chicago* (1903); M. M. QUAIFE, *Chicago and the Old Northwest* (1913); S. S. HEBBERD, *Wisconsin under the Dominion of France* (1890); J. N. DAVIDSON, *Unnamed Wisconsin* (1895); F. J. TURNER, *Indian Trade in Wisconsin* (in *Johns Hopkins University Studies in Hist. Pol. Sci.* 1891); KELLOG, *The Fox Indians during the French Régime* (Wisc. State Hist. Soc. Proc. 1907: 142–188); RE(O)BOK, *The Last of the Mus-qua-kies* (reprinted in Iowa Hist. Record 17: 305–335). Quite a few facts can be gleaned from *A collection of Meskwaki Manuscripts*, prepared by Cha kā ta ko si, published by the State Historical Society of Iowa, 1907, but as no English translation accompanies the text, use of it is confined to a few specialists or Meskwaki Indians.

[36] See the *Handbook of American Indians* under the article *Atchakangouen*.

[37] LA POTHERIE. *Savage Allies of New France*, apud BLAIR, Op. cit. 1: 360.

[38] Ed. THWAITES, 58: 41.

[39] On the note, ibidem, 293, see various articles in the *Handbook of American Indians*.

[40] JONES, *Amer. Anthrop.* n. ser. 6: 370; *Handbook of American Indian Languages*. Pt. 1: 741; apud STEWARD, Loc. cit. 79.

[41] See the ed. of THWAITES, 8: 302.

but the Huron designation of the *Meskwakies*, as stated by Hewitt in the *Handbook of American Indians*. For *Skenchiohronon* means "the Fox people," and the identification by Hewitt rests also upon that made by Potier (circa 1750).[42] It should be expressly noted that the Wyandot designation for the Meskwakies, collected by Gatschet in 1881, namely, *Skäxshurunu* "fox people," derived from *skäxshu* "the red fox," is more than ample confirmatory evidence. Accordingly we know that Le Jeune mentions the Fox Indians in the *Relation* of 1640.[43] Now since the Fox are cited in connection with the Sauk, Potawatomi, Kickapoo, Winnebago, and Crane Miami we have every reason to believe that their habitat at the time was in the vicinity of the Green Bay region. For the identification of the Huattoehronon, Attistaehronon, Ontarahronon, Aoueatsiouaenhronon, and Attochingochronon see the *Handbook of American Indians*. [Hewitt's identifications are at least partially supported by Potier.] Le Jeune adds "I have taken their names from a Huron map that Father Paul Ragueneau sent me." It is not known from whom Ragueneau obtained the map, though it is natural to think of Nicolet in this connection, for Ragueneau had a conference with Nicolet in the spring of 1641 near Three Rivers.[44] As is known, Jean Nicolet was in the vicinity of Green Bay in 1634. Le Jeune (op. cit. 231) locates the Potawatomi and Nation of the Fork[45] as being in the neighborhood of the Winnebago, and adds (p. 233) "I will say, by the way, that sieur Nicolet, interpreter of the Algonquin and Huron languages for the Gentlemen of new France, has given me the names of these nations, which he himself has visited, for the most part in their own country." Now if the Potawatomi and the Nation of the Fork were in the neighborhood of the Winnebago in 1634, it is highly probable that Sauk and Fox also were at least in that general vicinity. There is no *argumentum ex silentio*, for Le

[42] PILLING. *Bibliography of Iroquoian languages*. Bur. Amer. Ethnol. Bull. 6: 135, 136.

[43] THWAITES' ed. of the *Jesuit Relations*, 18: 235.

[44] *Jesuit Relations*, ed. THWAITES, 8: note 29, 9: 312.

[45] Rasaouakoueton: see article *Nassauaketon* in the said *Handbook*.

Jeune expressly says, "These are the names of a part of the nations which are beyond the shores of the great river Saint Lawrence and of the great lakes of the Hurons on the North." I think that the following extracts from the *Jesuit Relations*[46] may clarify the situation: "the Ousaki, and other Tribes,— who, driven from their own abode, the Lands towards the South, near Missilimakinac, have sought refuge at the head of the bay;" "the Poteouatami, the Ousaki, and the nation of the Fork also live here, but as foreigners, driven by their fear of the Iroquois from their own territories, which lie between the Lake of the Hurons and that of the Ilinois." [Both extracts are from the *Relation* of 1670–'71.] It is not at all likely that the Sauk (Ousaki) would have remained in the lower Michigan peninsula to face the enemy alone after the Potawatomi and the Nation of the Fork had been driven out. We must rather assume a general exodus at the same time, including the Fox (the intimate relations of the Sauk and Fox are well known). Hence C. W. Butterfield[47] is surely in error regarding the Sauks, and probably the Foxes when he states that they had not migrated from the east at the time of Nicolet's great voyage. According to a note in the *Jesuit Relations*[48] the Skenchiohronon [Foxes, not Neuters] are indicated on (S.) Sanson's map (of 1656) by Squenguioron. As a matter of fact the map has Squenquioron, at the end of Lake Erie. If this identification be correct,[49] the map is probably inaccurate; we have seen above, that in 1640 Le Jeune cites the Fox in connection with the Suak, Potawatomi, Kickapoo, Winnebago, and Crane Miami which certainly points the region of Green Bay as their habitat. Now the differences between the language of the Sauks and Foxes, and Kickapoos for that matter, are very small; and if the ancient home of the Sauks was in the lower Michigan peninsula (vide supra), so was

[46] Ed. THWAITES, 55: 103 and 183, respectively.

[47] JOHN NICOLET. *Discovery of the Northwest*, 64: 1881.

[48] Ed. THWAITES, 8: 302.

[49] See the synonymy under the article *Wyoming* in the *Handbook of American Indians* for BEAUCHAMP'S conjecture regarding Scahentoarrhon.

that of the Foxes. If the Foxes had been driven out previously, it is entirely possible small parties may have returned. But I do not think the traditional statements of the Sauk, Fox, and Ottawa,[50] locating the Foxes in the lower Michigan peninsula, should be taken too seriously, for it may well refer to the later raids, especially to the fight at Detroit. It would mean that traditional history, going back practically 200 years, could be relied upon. Similarly, traditional statements of the Foxes having been driven up the Grand River from the Gulf of St. Lawrence or having had their origin near Niagara Falls,[51] are to be rejected, because we know the history of the area under discussion for a time anterior to 1634. The construction that I place on the statements is that the wars with the Iroquois and Neuters made a deep impression, and that the geography is mixed; that the Foxes often went to Montreal, and even fought at Lake George; it is likely some children may have been born on such trips, and they may have been told their birth-place, and passed it on. Thus also is to be understood the well-known statement of Black Hawk. The Rhode Island origin of the Foxes[52] is too absurd to combat seriously. I may refer briefly to Tailhan's discussion of the early home of the Foxes.[53] His argumentum ex silentio falls to the ground, for the *Relation* of 1657–'58 says distinctly "you will see the names of the principal Nations,"[54] not "all the Nations." Kellog's paper suffers from a wrong identification of the *Outitchakouk* (vide supra), ignorance of the fact that the *Skenchiohronon* was a synonym of the Fox Indians, and from too great reliance on traditional history. The reference of Re(o)bok to Shea's article,[55] crediting the latter with stating that Nicolet met the Foxes in Wisconsin in 1634

[50] MARSTON, apud Blair, 21: 146; A. BLACK BIRD, *Hist. of the Ottawa and Chippewa Indians*, 24.

[51] FORSYTH, apud Blair, 2: 183–184; GRIGNON, *Wisc. Hist. Coll.* 3: 265.

[52] ATWATER. *Indians of the Northwest*, 88; repeated by GREEN, *The Mesquaki Indians*, Red Man 5: 47–52, 104–109; queried by RE(O)BOK, loc. cit.

[53] BLAIR. Vol. 2: 250, 251.

[54] *Jesuit Relations*, ed. THWAITES, 44: 239.

[55] Wisc. Hist. Soc. Coll. 3: 124–138.

is due to uncritical reading. Nicolet very likely met the Foxes in Wisconsin, but Shea does not say so. He begins his history of them in 1666–1667. Steward's discussion of the early history of the Foxes suffers from a wrong identification of the Ouachegami[56] with the (Outagami which shows his ignorance of Algonquian languages), his failure to know that *Skenchiohronon* is a synonym of Fox, and his too great reliance on traditional history; but it may be noted that he utilized the information contained in La Potherie regarding the two lineages of the Outagami which have been ignored by later writers.

The recent history of the Fox Indians can be readily followed in the *Reports* of the Commissioner of Indian Affairs, and local newspapers. The *Mesquakie Booster,* a periodical devoted to the present day interests of the Fox Indians, has recently discontinued.

POPULATION

In any attempt to determine the population of an Indian tribe in previous times, we must take into account exaggerations, either unintentional or intentional. The population of the Foxes is concisely treated in the articles Fox and Sauk in the *Handbook of American Indians.* The most reliable estimates of the entire Fox population in early times are those of Pike (1805) 1750, Lewis and Clark (1806) 1200, Beltrami (May 29, 1823) 1600, *Ann. d.l. Prop. de Foi* (1830) 1500, *Report of the Commissioner of Indian Affairs* (1837) 1600. Pike gives the number of warriors as 400, Lewis and Clark as 300. It will be seen that, roughly speaking, from their figures the total population is four times the number of warriors. In this way an estimate may be made for earlier times when only the warriors are listed. I now give some estimates of the number of warriors:

1666–1667 (*Jesuit Relations*) 1000 (gross exaggeration).
1667–1670 (*Jesuit Relations*), 400.
1714 (Charlevoix), 500.
1761 (Wisc. Hist. Soc. Coll. 1: 32), 350.
1763 (Col. Dioc. N. Y. 10: 583), 320.
1777 (Houck, Spanish régime, 1: 146), 300–350.
1783 (Mass. Hist. Coll. I. 10 [1809]: 123), 300.

[56] Article *Wachegami* in *Handbook of American Indians.* Bur. Amer. Ethnol. Bull. 30.

With the exception of the first estimate, we have a series that is entirely reasonable. The struggle at the Butte des Morts easily accounts for the decrease in population after 1714. The estimates of Bouquet and Chauvignerie in 1764 and 1763, respectively,[57] and Buchanan[58] are too modest, as is that of Jno. Long (about 1780, published 1791). With the exception of Chauvignerie (100), these range from 200–250. The statement of Charlevoix that there were 3000 women in 1714 is pure exaggeration. This would make the number of women six times that of the men, which does not accord with the proportions given by Pike and Lewis and Clark. The extravagant figure of 3202 in 1819[59] as the total population must be considered as a deliberate invention. The figure of 2000 in 1822 (given by Marston and Morse) is a simple exaggeration. The last separate enumeration of the Foxes is in 1841, where 1600 is given. Here our real difficulties begin. For by enumeration with the Sauks, we lose trace (for a while at least) of the number of true Foxes. And what is more, we are involved in the gross exaggerations in the enumerations of the Sauks. To make the matter clear, and at the same time not to go into this at too great length as it is a side-issue, it is necessary to state that the most reliable estimate of the Sauks in the early days is that of Lewis and Clark, namely, 2000. That of Pike is 2850, that of the *Ann. d. l. Prop. de Foi* (1830) is 2400. These are exaggerations of a comparatively mild order; soon we see the wildest kind of guesses; in 1819 we get 3847, in 1822, 3000 and 4500, in 1823, 4800, which figure we find again in 1837 and 1841, not counting the Missouri Sauks (500, the percentage of Foxes among these cannot be determined, but apparently was small). Drake in 1820 gives the combined Sauk and Fox as about 3000 "one-fifth of whom may be warriors." The state of affairs can be seen by the remarks of Marsh in 1834; we are told that the agent counted the combined Sauk and Fox as 6400, but that others estimated the number

[57] Schoolcraft, 5: 554, 559.

[58] Between 1770–1780, reported by HECKWELDER.

[59] Wisc. Hist. Soc. Coll. 20.

to be between 2000 and 2400, adding that he himself considered 2000 to be nearer the figure. Apparently the fact that the population was exaggerated was gradually making headway in officialdom, for, in the *Report of the Commissioner of Indian Affairs* in 1838, this is taken into account and the Mississippi Sauk population is given as 2100. But such is the attachment for large figures, apparently to balance at least partially his over-estimates of the Sauks, that the agent gives the reckless figure of 2446 for the Foxes. Unfortunately officialdom could not be contented with such modest figures for the Sauks, and in 1841 we have the old exaggeration (vide supra). A wholesome reaction came in the next year when a treaty for the removal of the Sauks and Foxes from Iowa was effected, and from 1842 to 1845 the combined Sauk and Fox population is given as about 2300. An attempt at honesty was made in 1841 when in spite of the erroneous separate enumeration of the Sauks, the combined population of the Sauk and Fox of the Mississippi is given as 2300. It is to be borne in mind that in the same official document the Fox population is given as 1600! Other exaggerations of the Sauk population are passed over, save that in 1826 Forsyth gives the number of warriors as 1000 and Keocuck as 1200.[60] Summing up for the population prior to the removal to Kansas, we may say that if we accept the figures of Lewis and Clark, Drake, Marsh, and the report of the Commissioner of Indian Affairs for 1842, we have an orderly sequence, such as may be readily accounted for (as by the Black Hawk war, and natural causes); the acceptance of the larger figures (and this applies especially to the Sauk) involves us in hopeless meshes. From now, owing to the merging of the enumeration, the situation is difficult. The removal of Indian tribes ordi-

[60] WENNEBEA (apud *Narrative of an Expedition to the Source of St. Peter's River* . . . 1823, compiled by WILLIAM H. KEATING, vol. 1: p. 219) says, "upwards of a thousand warriors . . . the real number of warriors of pure Sauk extraction does not . . . exceed two hundred." The adoption of prisoners of war accounts for the rest. Are we to understand something of this sort from Forsyth's and Keocuck's figures?

narily involves a considerable loss in population; but in 1849 the combined Sauk and Fox of the Mississippi is given as 3000; but it is officially known that one-half the Sauk and Fox of the Missouri had joined them. In 1851 three hundred perished by cholera; in 1852 three hundred died of smallpox. According to the report of the Commissioner of Indian Affairs for 1853 there were 2173 Sauk and Fox of the Mississippi; in the report for 1857 we learn the Sauk and Fox of the Mississippi in 1853 was 1748: but no explanation of the discrepancy is given. In 1857 the population of the Sauk and Fox of the Mississippi is given as 1367, and those of the Missouri as 350. The probable interpretation of this is that the Sauk and Fox of the Missouri who had joined those of the Mississippi had rejoined their own body. From this time on the population diminished slowly but surely; and the details can be readily found in the reports of the Commissioner of Indian Affairs. What is more important to us is that the Foxes (at least a majority of them) eventually left Kansas for Iowa, where they purchased land. Their population eventually reached to about 400 when an epidemic of smallpox swept many away. To-day they are 350 in round numbers. Officially they are called "Sauk and Fox;" but in language they are Foxes; and also in ethnology. Even the government in its treaties recognized the Foxes as distinct as late as 1859 so that the much heralded amalgamation with the Sauks is shown to be a myth. It may be noted that there are some Sauks among "Sauk and Fox" near Tama, Iowa; and many others have Sauk blood; still others have French, English Potawatomi, or Winnebago blood; and some are hopeless mixtures. Briefly, I doubt if there are still (1918) any Foxes living who are absolutely free from foreign mixture. Another point may here be taken up. Officially the number of full-blooded Indians is very high; but this is an exaggeration, as I know from personal field work. In closing it may be said that there are some Foxes among the "Sauk and Fox" (who are mainly Sauks) of Oklahoma, and

others doubtless have Fox blood; but their proportion is unknown.[61]

THE ALLEGED IROQUOIS ORIGIN OF THE FOXES

N. H. Winchell,[62] attempts to prove that the Foxes (Outagami) were originally an Iroquoian people (thus repeating Smith's old error). The arguments adduced are so absurd that they would not merit any attention were the paper not in a periodical of high standing. The statement that the Foxes were almost annihilated by the Ojibwa in 1777 simply shows that Winchell could not have investigated the question of the Fox population with any care; the figures given by Lewis and Clark, Pike, *Ann. d. Prop. de la Foi*, Marston, and Forsyth, give the lie direct to this imputation.[63] The argument is that the Foxes being virtually annihilated by the Ojibwa were absorbed by the Sauks, and began to be transformed, language and all, and consequently present linguistic investigations would be of little value unless such an amalgamation were taken into consideration. The question of annihilation has been dealt with above; as to absorption, undoubtedly many Foxes have Sauk blood, but Fox ethnology has remained distinct from Sauk ethnology in at least certain respects.[64] The linguistic point raised by Winchell can readily be overthrown. The language spoken by the Foxes of to-day is more archaic than that spoken by living Sauks, as I have shown elsewhere;[65] and it should be noted that Kickapoo agrees with Fox in many of these differences. Hence the ques-

[61] STEWARD (*Lost Maramech and earliest Chicago*, 1903), discusses the Sauk and Fox populations, and comes to the conclusion that they increased very rapidly between 1805 and 1825. Had he carried his investigations further he would have seen that the supposed increase in reality did not take place (vide supra). TURNER (loc. cit.) also touches on the Fox population in so far as he gives various early estimates of the number of warriors, closing with 1762.

[62] Proceedings of the Mississippi Valley Historical Association, 1910–1911: 181–188.

[63] A similar error is to be found in the *Handbook of American Indians* under the article "Foxes."

[64] For example, in social organization.

[65] Bur. Amer. Ethnol. Ann. Rep. 28.

tion of linguistic assimilation does not come up at all. The argument that the Foxes were not Algonquians because "they spoke a language which could not be understood by an Ottawa interpreter," is positively ludicrous. What use would an Ottawa interpreter be among the Sauk, Kickapoo, or Delaware? He could undoubtedly understand isolated words, but not whole sentences. But what does that prove? Simply that Sauk, Kickapoo, and Delaware are too remotely related to Ottawa to be mutually intelligible. In precisely the same way an English speaking person would be useless as an interpreter among Germans unless he had studied and mastered their language. Allowing for the sake of argument that Iroquoian pottery has been found in Wisconsin in localities where the Foxes have dwelt for a long period, that does not prove the Foxes were Iroquoian in a linguistic sense, for it could easily be accounted for by acculturation. What have wars on other Algonquian tribes to do with the problem of whether or not the Foxes linguistically were Algonquian or not? The English and Germans fought against each other in the Great War. Nor have political alliances anything to do with linguistic relationship; the Japanese to-day are the allies of the English. As to the statement that they were mound builders thus resembling the Iroquois in contrast with all Algonquian tribes, which I doubt, what has a cultural phenomenon to do with a linguistic one? Or what have temperamental differences, a psychic phenomenon, to do with a linguistic problem? Nothing. The alleged original home of the Foxes in an Iroquois country is shown in the section dealing with their history to be nothing more than a misunderstanding, to put it mildly. In any case this has nothing to do with the question whether or not the Foxes were originally Iroquoian in a linguistic sense. Thus all the arguments crumble down, one by one.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors The abstracts should conform in length and general style to those appearing in this issue.

ORNITHOLOGY.—*The birds of the Tambelan Islands, South China Sea.* HARRY C. OBERHOLSER Proc. U. S. Nat. Mus. **55**: 129–143. 1919.

The Tambelan Islands lie in the southern part of the South China Sea, about 100 miles west of Borneo. Dr. W. L. Abbott, who was the first ornithologist to explore these islands, spent two weeks there from August 3 to August 15, 1899, during which time he collected 53 birds, representing 12 species. These, together with his field notes, bring the number of avian species now known from these islands collectively up to 22. A list of these, with critical notes on specimens obtained, forms the present contribution. There are apparently few, if any, endemic forms in these islands; and their affinities so far as birds are concerned seem to be with the Anamba Islands which lie 150 miles farther north, rather than with the nearer Bornean coast. The form of *Orthorhamphus magnirostris* occurring in this region is apparently without a name and is here called *Orthorhamphus magnirostris scommophorus.* H. C. O.

ORNITHOLOGY.—*Notes on birds collected by Dr. W. L. Abbott on Pulo Taya, Berhala Strait, southeastern Sumatra.* HARRY C. OBERHOLSER. Proc. U. S. Nat. Mus. **55**: 267–274. 1919.

The island of Taya is situated at the eastern end of Berhala Strait about 30 miles north of the coast of Sumatra. Dr. W. L. Abbott visited this island and the near-by Nyamok Islets from July 26 to July 28, 1899, and obtained a small collection of 30 specimens of birds representing 8 species. Two other species were seen but not obtained. Critical notes here presented include the description of two new subspecies, *Lamprocorax panayensis richmondi* and *Cinnyris ornata microleuca,* both of which are apparently peculiar to this island. Of considerable

interest is a specimen of the rare pigeon commonly known as *Columba grisea* (Bonaparte), which Dr. Richmond renamed *Columba phasma*, but which has an earlier name in *Columba argentina* Bonaparte.

H. C. O.

ORNITHOLOGY.—*Notes on the wrens of the genus Nannus Billberg.* HARRY C. OBERHOLSER. Proc. U. S. Nat. Mus. 55: 223–236. 1919.

The present investigation of the genus *Nannus* (olim *Anorthura*) concerns chiefly the American forms, but a few changes in Old World races are noted. Altogether there are 36 forms in the genus, and although some of these formerly stood as species, they are now considered subspecies of the European *Nannus troglodytes*. Birds from middle Europe differ from the typical race of Norway and Sweden and should be subspecifically separated as *Nannus troglodytes sylvestris* (Brehm). The bird heretofore known as *Troglodytes pallidus* Hume should now be called *Nannus troglodytes tianschanicus* (Sharpe). The race described as *Olbiorchilus fumigatus* Clark from the Amur region in eastern Siberia proves to be a good subspecies and should stand as *Nannus troglodytes amurensis* (Clark). The bird named by Buturlin *Anorthura fumigata ussuriensis* is apparently the same. The American forms of this genus are now increased to 9 by the addition of the following three new subspecies: *Nannus troglodytes kiskensis* from Kiska Island, Alaska; *Nannus troglodytes tanagensis* from Tanaga Island, Alaska; and *Nannus troglodytes petrophilus* from Unalaska Island, Alaska.

H. C. O.

ORNITHOLOGY.—*Birds of a Washington City dooryard.* HARRY C. OBERHOLSER. Amer. Midl. Nat. 6: 1–13. 1919.

The observations here recorded were made in the built-up portion of the City of Washington from May 5, 1911, to May 1, 1918. The result again exemplifies the fact that there is ample opportunity for natural history study even in the midst of a crowded city. The total number of species herein recorded is 100, with notes on the dates of their occurrence. The largest number of these seen on any one day was 18. Among these, the most interesting for their appearance in city districts were probably *Colinus virginianus virginianus*, *Porzana carolina*, *Bartramia longicauda*, five species of the genus *Hylocichla*, and *Loxia curvirostra minor*.

H. C. O.

ORNITHOLOGY.—*Description of a new seaside sparrow from Florida.* ARTHUR H. HOWELL. Auk 36: 86–87. January, 1919.

The discovery of a new species of bird in North America at the present time is a scientific event of some importance, although the same is not true of a subspecies. Explorations in southern Florida have brought to light what is evidently an entirely new species of the genus *Thryospiza*. It differs so remarkably from all the other forms of the genus that intergradation seems never likely to be found. It most nearly resembles *Thryospiza maritima sennetti* of the coast of Texas, from which, however, it differs conspicuously in its more sharply streaked and more extensively white lower parts. In the general character of its under parts, it is more like *Thryospiza nigrescens* of eastern Florida, but the color of its upper surface is entirely different. It is appropriately named *Thryospiza mirabilis*.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Bird records from the Sacramento Valley, California.* ALEXANDER WETMORE. Condor 21: 73–74. 1919.

During the period between August 17 and October 17, 1918, bird observations were carried on in the Sacramento Valley, between Marysville, Maxwell, and Tehama. Notes on 12 of the most interesting species noted are presented here. The northern limit of the range of the following species in the interior of California is apparently extended by these observations: *Dendrocygna bicolor*, *Hydroprogne caspia imperator*, *Egretta thula thula*, and *Tyto alba pratincola*.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Notes on the structure of the palate in the Icteridae.* ALEXANDER WETMORE. Auk 36: 190–197. 1919.

The keel on the palate of the grackles of the genus *Quiscalus* is a well-known character. Investigation shows it to be a projection developed as a fold in the horny sheathing of the palate. Its use, hitherto unknown, has recently been ascertained by field observation. It is now found to be of assistance in obtaining kernels from acorns by cutting the shells, and has other similar functions. Several other genera of Icteridae have indication of a similar projection on the palate. This is most prominent in *Icterus gularis*, although apparently absent in all other species of the genus *Icterus*. In this species it is

well developed, knob-like, and almost as prominent as in *Quiscalus*. It constitutes thus an excellent generic character, and necessitates the segregation of *Icterus gularis* and its subspecies under the generic name *Andriopsar* Cassin. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Descriptions of apparently new Colombian birds.* W. E. CLYDE TODD. Proc. Biol. Soc. Wash. **32**: 113–118. June 27, 1919.

A study of the South American collections in the Carnegie Museum has resulted in the further discovery of 5 new species and 14 new subspecies, all from Colombia, brief descriptions of which appear in this paper. The species are: *Myiobius semiflavus* from El Tambor, Santander, Colombia; *Grallaria alticola* from Lagunillas, Boyaca; *Veniliornis chocoensis* from Malagita, Choco; *Odontophorus variegatus* from La Pica, Santander; and *Crypturus idoneus* from Bonda, Santa Marta. The subspecies are: *Atlapetes semirufus majusculus* from Peña Blanca, Santander, Colombia; *Phoenicothraupis rubica coccinea* from La Colorado, Boyaca; *Cistothorus aequatorialis fulvescens* from Paramo Guerrero, Santander; *Leucolepis lawrencii assimilis* from Sautata, Rio Atrato; *Leucolepis phaeocephalus propinquus* from Jaraquiel, Bolivar; *Mecocerculus leucophrys notatus* from Leonera (near Caldas); *Platytriccus albogularis neglectus* from La Colorado, Boyaca; *Pipra erythrocephala flammiceps* from El Tambor, Santander; *Pipra velutina minuscula* from Quibdo, Rio Atrato; *Hylopezus perspicillatus pallidior* from El Tambor, Santander; *Leptasthenura andicola exterior* from Lagunillas, Boyaca; *Deconychura typica minor* from El Tambor, Santander; *Celeus innotatus degener* from El Tambor, Santander; and *Nonnula frontalis pallescens* from Fundacion, Santa Marta. HARRY C. OBERHOLSER.

ORNITHOLOGY.—*The migration of North American birds. IX. Crows.* HARRY C. OBERHOLSER. Bird Lore **21**: 100–102. 1919.

The well-known *Corvus brachyrhynchos*, as represented by five subspecies, including *Corvus brachyrhynchos caurinus*, occupies the greater part of the United States and Canada. It is resident except in the northern part of its range, for which region the dates of its spring and autumn migration are here given. The distribution of *Corvus ossifragus*, the European *Corvus frugilegus*, and the European *Corvus cornix*, are also added as of interest in this connection.

H. C. O.

ORNITHOLOGY.—*Description of a new Conurus from the Andaman Islands.* HARRY C. OBERHOLSER. Proc. Biol. Soc. Wash. **32**: 29–32. April 11, 1919.

Examples of *Conurus fasciatus* from the Andaman Islands prove to differ from the mainland birds in their larger size and paler coloration, and are here separated as a new subspecies, *Conurus fasciatus abbotti.* With this addition there are now five races of *Conurus fasciatus*.

H. C. O.

ORNITHOLOGY.—*Six new birds from Celebes and Java.* J. H. RILEY. Proc. Biol. Soc. Wash. **32**: 93–96. May 20, 1919.

Three additional species and two subspecies from Celebes and one subspecies from Java have been brought to light by further study of the bird collections made by Mr. H. C. Raven. The species are: *Megalurus celebensis* from Besoa, Celebes, the first of its genus to be found in Celebes; *Dicruropsis montana* from Besoa, Celebes; and *Pachycephala pluviosa* from Rano Rano, Celebes. The subspecies described are: *Excalfactoria chinensis palmeri* from Daroe, Java; *Anas superciliosa percna* from Koelawi, Celebes; and *Zosterops atrifrons surda* from Rano Lindoe, Celebes.

HARRY C. OBERHOLSER.

ORNITHOLOGY.—*Description of a new race of the western gull.* JONATHAN DWIGHT. Proc. Biol. Soc. Wash. **32**: 11–13. February 14, 1919.

The western gull, *Larus occidentalis*, is found to be separable into a northern and a southern subspecies. The latter, which differs from the typical form of the coast of Oregon and Washington in its decidedly darker mantle and reduction of gray area on the primaries, is here named *Larus occidentalis livens.* It ranges from the coast of central California south to both coasts of Lower California.

HARRY C. OBERHOLSER.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

GEOLOGICAL SOCIETY OF WASHINGTON

338TH MEETING

The 338th meeting of the Society was held in the auditorium of the Cosmos Club on Wednesday evening, May 28, 1919, at 8 p.m.

Informal Communications

Mr. LaForge spoke of a fairly wide-spread misapprehension of the exact meaning of the words *talus* and *shingle* and the resultant increasing tendency to use them incorrectly. *Talus* seems to be used to some extent in the United States for the material which in reality constitutes *a* talus. The word is synonymous with *scree* which is commonly used in Great Britain. It means "a heap of coarse rock waste at the foot of a cliff or a sheet of such waste on a slope below a cliff," and its use should be confined to the heap or sheet and not extended to the constituent material, which is *rock waste*.

There seems to be a rather general idea that *shingle* means gravel composed chiefly of flattened pebbles which have been arranged by gravity, waves, or currents so as to overlap like shingles on a roof. This is entirely incorrect, as the word has no relation to the ordinary English word *shingle* (originally shindle), but is derived from the same Germanic or Norse root from which comes our common word *sing*, the *h* having been introduced through corruption, and it refers to the peculiar sound made by the material when trod upon or when rolled down the slope of the beach by a receding wave.

This brings up the question regarding the origin of the sound, and, therefore, regarding the essential or distinctive character of shingle. The dictionaries and those text-books which define the word state that it is "beach material coarser than ordinary gravel," but manifestly such a definition is inadequate, as some "singing" beaches consist of fine material and many beaches composed of coarse gravel do not "sing." Apparently the subject has not been investigated experimentally, but the number of field observations have led the speaker to the following tentative hypothesis:

The production of a sound approximating a musical note requires a certain degree of uniformity in the sound-making material and the pitch of the sound depends on the dimensions of the material, and of the resonating space, if there be any. To have such uniformity it is therefore necessary that the pebbles be of approximately the same size, hence the interstices will not be filled with finer material, as in

ordinary gravel, and resonating space of approximately uniform "mesh" will be provided. Field observation shows that it is also essential that the pebbles be of fine-grained dense rock and smoothly rounded, so that the rubbing of one upon another will tend to set up definite vibrations rather than irregular jars, and shows further that the coarser the material of a "singing" beach the lower the note produced. If this suggested explanation be correct, *shingle* should be defined as "beach material, coarser than sand, consisting of smoothly rounded pebbles of dense, fine-grained rock, of approximately the same size, and hence not having the interstices filled with finer material, which gives out a sound resembling a musical note, when trod upon or when rolled about by waves."

Mr. FRANK L. HESS said that tourmaline cobalt-bearing veins occurring in the Blackbird region, Lemhi County, Idaho, are dense black and occur in a dark, fine-grained, thin-bedded quartzite. The cobalt is in many places difficult to see, but it shows up on crushing and panning the rock. A polished section was exhibited showing a mass of microscopic tourmaline crystals with clouds of included cobalt minerals, mostly cobaltite.

Dr. H. M. AMI called attention to the fact that on the shores of the Dead Sea in Palestine there are innumerable fresh water shells washed up by the waves along with drift wood and other forms of vegetable matter. The hypersalinity of the water precludes any form of life. He surmises that these shells presumably are brought into the sea by Jordan River, and calls attention to the fact that the presence of freshwater shells in strata does not necessarily predicate that the water in which the sediments were laid down was fresh.

Regular Program

E. W. SHAW: *Present tendencies in Geology. III. Stratigraphy.*

(This paper will be published later in this JOURNAL.)

M. I. GOLDMAN: *General character, mode of occurrence, and origin of glauconite.*

The characters of the mineral were briefly reviewed, and it was pointed out that there are a number of varieties in addition to the common form in rounded, compound-polarizing grains. Some of these seem to have been deposited epigenetically from solution, but the speaker did not believe that there is good evidence for the deposition of any of them from solution syngenetically. The importance of further study, especially chemically, of the well defined, micaceous green crystals sometimes found associated with the cryptocrystalline forms of glauconite, and believed to be glauconite, was emphasized.

The chemical composition and mineralogical affinities were discussed. The potassium content, which averages around 7 per cent, distinctly differentiates glauconite from the chlorites which it resembles in many of its mineralogical characters, and the predominance of

ferric over ferrous iron and the fact that glauconite seems to be an orthosilicate points in the same direction. Then too, the molecule of water which appears to be an essential part of its composition would place it rather with the vermiculites than the chlorites. Allying it with the chlorites, on the other hand, is the magnesia content which seems to be pretty persistent. The chemical composition presents a fundamental difficulty, however, since it is uncertain whether the mineral is a definite crystalline substance or a colloform mixture.

Glauconite is a characteristic phase of certain terrigenous *marine* sediments and very widely distributed around all the continents. But it is rare in the delta type of terrigenous deposit on the one hand and in pellagic deposits on the other. Concerning its mode of formation there is great uncertainty, but it seems to develop in small segregated pellets of clay (generally 1 mm. or less diam.) when there is organic matter present. The process assumed has been the reduction of the sulfates of sea water to sulfides which form iron sulfide with the iron present in the clay. This sulfide is believed to combine with silica in the clay and the iron silicate thus formed to take up potassium from the sea-water. The combination of iron sulfide with silica to form a silicate has been brought about experimentally, but the reaction was prevented by an excess of hydrogen sulfide. On the basis of the facts summarized the speaker presented the hypothesis that glauconite is one of three characteristic modes of occurrence of iron in marine deposits, being an intermediate product between high organic content and reducing conditions yielding the sulfide on the one hand, and low organic content with oxidizing conditions producing the hydrous oxides on the other.

Geologically, also, glauconite is a very widely distributed and common mineral, having been found in deposits of every period. It occurs particularly characteristically, however, just above unconformities, that is in transgressing (perhaps also in regressing) formations, and preeminently in connection with the great transgression of the lower part of the Upper Cretaceous. This stratigraphic position has not been adequately explained. The frequent association of glauconite and phosphate in both recent and ancient deposits is familiar, and Murray has pointed out a relation, at least partial, of phosphate with great extremes of surface temperatures of the ocean. Cayeux has suggested that such instabilities of temperature might be produced by extensive movements of the earth's crust and the same explanation may be applicable, in part, to the geologic occurrence of glauconite.

G. R. Mansfield: *General features of the glauconite marls of New Jersey.*

(This paper is to be published in *Economic Geology.*)

E. O. Ulrich: *Paleozoic glauconite zones and suggestions as to their origin.*

R. W. Stone, *Secretary.*

The Chemical Society of Washington has secured permission from Maj. Gen. William L. Sibert for its members to visit the government gas plant at Edgewood Arsenal, Edgewood, Maryland, on a Saturday about the middle of October. Others in the city who are interested will be welcome. The chemists of Philadelphia, Wilmington, and Baltimore will also visit the plant on the same day. Details of the arrangements will be announced later.

Word has been received that Messrs. ALLEN, FENNER, and ZIES, of the Geophysical Laboratory's party in Alaska, have arrived safely at Kodiak with collections of gases and emanations from the fumaroles of the Valley of Ten Thousand Smokes. This is the first news of the party since the National Geographic Society's expedition entered the Valley in June.

Mr. ROBERT ANDERSON, a petroleum geologist formerly on the U. S. Geological Survey, has returned from Stockholm, Sweden, where he represented the Shipping Board for the past 6 months, and is about to leave for London where he will have charge of geologic investigations for Pearson and Sons.

Mr. GEORGE H. ASHLEY resigned from the U. S. Geological Survey on September 1, having been appointed State Geologist of Pennsylvania.

Dr. ARTHUR F. BUDDINGTON of Brown University, recently in Washington with the Chemical Warfare Service, has joined the staff of the Geophysical Laboratory of the Carnegie Institution of Washington.

Miss ELEONORA F. BLISS, associate geologist on the U. S. Geological Survey, is on leave of absence and is visiting her father, General TASKER H. BLISS, in Paris.

Messrs. L. C. GRATON, FRANK A. HERALD, and J. H. HANCE, formerly geologists in the U. S. Geological Survey, are now engaged in expert work in the income tax section of the Internal Revenue Division of the Treasury Department.

Mr. H. E. HARING, recently in the Inspection Division of the Ordnance Department, has joined the staff of the Bureau of Standards, where he will be engaged in electrochemical research.

Prof. A. S. HITCHCOCK, systematic agrostologist in the Bureau of Plant Industry, left New York for British Guiana in September. He expects to study the grasses of that country, and will return in about four months. The work is being done in cooperation with the New York Botanical Garden and the Gray Herbarium.

Dr. ALES HRDLICKA, of the Smithsonian Institution, has been visiting Camp Dix and Camp Devens for the purpose of classifying certain anthropometric measurements being made during the demobilization of the soldiers.

Mr. PREVOST HUBBARD resigned in July from the Bureau of Public Roads, U. S. Department of Agriculture, and is now chemical engineer with the Asphalt Association, 15 Maiden Lane, New York City.

Mr. PAUL D. V. MANNING, formerly chemist with the Nitrate Division of the Ordnance Department, at the Fixed Nitrogen Research Laboratory, American University, is now electrometallurgist with the Chile Exploration Company of New York City.

Mr. LOUIS N. MARKOVITZ, who has been on leave of absence with the Chemical Warfare Service at Nela Park, Cleveland, Ohio, has returned to his work at the Insecticide Laboratory of the Bureau of Chemistry.

Dr. CHARLES L. PARSONS, Chief Chemist of the Bureau of Mines, has presented his resignation, to take effect November 1st. He has engaged offices for the American Chemical Society in the Mills Building Annex. He will also do a limited amount of private consulting and chemical engineering work.

Mr. E. W. SHAW, geologist of the U. S. Geological Survey, who has been cooperating with the Internal Revenue Office in determining the income tax on oil and gas properties, is in Europe on a two months' leave of absence doing consulting geologic work.

Dr. H. TEN KATE, the well-known anthropologist, who has been a resident of Japan for the past twelve years, visited Washington in August.

Prof. E. W. WASHBURN, recently acting chairman of the Division of Chemistry and Chemical Technology of the National Research Council, returned to the University of Illinois in September.

Mr. L. M. WHITMORE, formerly in charge of the chemical work on leather at the Bureau of Standards, resigned in August to accept a position in the Process Department of Leas and McVitty, Inc., tanners of sole leather, at Salem, Virginia.

Mr. CHARLES W. WRIGHT, a geologist formerly on the U. S. Geological Survey, who has been visiting in the United States for a month, has returned to Sardinia and Rome, where he has offices as consulting mining engineer.

Dr. RALPH W. G. WYCKOFF, of Cornell University, has joined the staff of the Geophysical Laboratory of the Carnegie Institution as assistant physicist

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 9 OCTOBER 19, 1919 No. 17

CRYSTALLOGRAPHY.—*The crystallography of morphine and certain of its derivatives.* EDGAR T. WHERRY and ELIAS YANOVSKY, Bureau of Chemistry.

Optical-crystallographic methods having proved to be of practical value in the identification of the cinchona alkaloids,[1] attention was directed by the writers to another group of alkaloids, namely, morphine and its derivatives, to ascertain if similar methods could be applied there. Commercial samples were purified (by the junior author) as described below, and crystallographic measurements were made to establish their identity with previously described material. On trying these substances by the immersion method under the polarizing microscope it was found that they dissolved so rapidly in every immersion liquid approaching them in refractive index that their identification by this method would be impracticable. It is probable that some of their salts, such as the hydrochlorides, being less readily soluble, would be better adapted for optical-crystallographic identification, and it is planned to prepare and study these compounds, although the withdrawal of the junior author from the Bureau of Chemistry has led to delay in carrying this out. The results of the crystallographic measurements of the alkaloids are, however, of considerable scientific interest, and this account of them has accordingly been prepared.

[1] Journ. Amer. Chem. Soc. 40: 1063. 1918.

MORPHINE MONOHYDRATE, $C_{17}H_{19}NO_3.H_2O$

Anhydrous morphine has apparently never been prepared in well-crystallized condition, but the monohydrate, which separates from all the usual solvents of this alkaloid, has been the subject of several crystallographic investigations. Brooke[2] described crystals showing a pinacoid, prism, and dome, his angle measurements, when transformed, yielding $\phi_{\text{prism}} = 63° 40'$ and $\rho_{\text{dome}} = 42° 20'$. Schabus[3] measured crystals with a pinacoid, a prism with $\phi = 63° 27'$ and a dome over the pinacoid with $\rho = 24° 54'$; he made the pinacoid and dome side- or

TABLE 1. ANGLE TABLE FOR MORPHINE MONOHYDRATE

RHOMBIC (BISPHENOIDAL); $a:b:c = 0.499:1:0.927$[a]

Number	letter	Symbols G'd't	Mill.	Description	Observed φ	Observed ρ	Calculated φ	Calculated ρ
1	c	0	001	Listed by Rammelsberg	......	......	......	0°00′
2	b	0∞	010	Dominant form; cleavage direction	0°00′	90°00′	0°00′	90°00′
3	m	∞	110	The only prism form	63°30′	90°00′	63°29′	90°00′
4	q	0½	012	Observed and taken as the unit by Schabus	......	.....	0°00′	24°52′
5	r	01	011	The best developed termination	0°00′	42°50′	0°00′	42°50′
6	p	1	111	Reported by Decharme	......	.....	63°29′	64°17′

[a] The axial ratio given is the average of those obtained by the various investigators of this substance. It is stated to but three decimal places because of the wide variations which appear to exist. The angles of the crystals here measured showed a maximum variation of ±20′, and the probable error of the observed value is about 5′.

brachy-forms. Lang[4] established the optical orientation on crystals with what appear to have been the same forms, but he took the pinacoid and dome as front or macro-forms. Decharme,[5] without measuring any angles, observed a development of bisphenoidal faces on crystals of two different habits.

[2] Ann. Phil. (N. S. 6) 22: 118. 1823; discussed by SCHABUS, *Best. Kryst.-gest. chem. Lab. erz. Prod.*, Vienna, 1855, p. 74, and by RAMMELSBERG, *Handb. Kryst.-phys. Chem.* II, 358. 1882.

[3] Loc. cit.; abstract in Jahresb. 1854: 510, and in RAMMELSBERG, loc. cit.

[4] Sitzb. Akad. Wiss. Vienna 31: 115. 1858.

[5] Ann. Chim. phys. (Ser. 3) 68: 160. 1863.

The alkaloid liberated from a commercial sample of the hydrochloride was recrystallized from absolute methyl alcohol until its specific rotation remained the same in two consecutive crystallizations. The final value for a 1% solution in methyl alcohol was $[\alpha]_D^{20°} = -131.7°$. The usually recommended recrystallization from amyl alcohol was found to be less satisfactory.

The crystals finally obtained from methyl alcohol, which attained a diameter of about 1 mm., were measured on a Goldschmidt two-circle goniometer, with the results presented in table 1. The orientation adopted is that of Schabus, but the steeper dome is taken as the unit form, giving a value different from his for axis *c*.

The essential agreement between the measurements of preceding authors and those here reported indicates that morphine normally crystallizes, as monohydrate, in a single form, there being no evidence of polymorphism.

Partial optical descriptions of this substance have been published by Lang,[6] by Kley[7] and by Wright[8] but there are considerable discrepancies among their results. On examining our material by the immersion method, using liquids made up chiefly of a petroleum oil, in which the alkaloid is but slightly soluble, the data of Lang and of Wright were confirmed for the most part, and Kley's value for one refractive index could be explained as a mean between the largest and smallest indices, while his axial angle must be 2 V. The data obtained were:

Refractive indices $[^{20°}_{D}]$ $\alpha = 1.580$, $\beta = 1.625$, $\gamma = 1.645$, $\gamma - \alpha = 0.065$, all $\pm$ 0.005. Index β is usually shown lengthwise of the rods, and one of the other, or intermediate, values, crosswise; the optic axial plane is perpendicular to the elongation of the crystals; axial angle 2E is very large, approximately 125°; sign —; dispersion strong with $2E_r > 2E_v$.

CODEINE, MORPHINE METHYL ESTER, $C_{18}H_{21}NO_3$

This alkaloid crystallizes in both anhydrous and hydrous forms. The former was obtained from carbon disulfide solution and

[6] Loc. cit.

[7] Zeitschr. anal. Chem. 43: 164. 1904.

[8] Journ. Amer. Chem. Soc. 38: 1655. 1916.

described crystallographically by Arzruni.[9] The forms observed were front and side pinacoids, two prisms, front and side domes, and right and rarely left sphenoids, the important angles being, as transformed: $\phi_{110} = 47° 05'$ and $\rho_{101} = 28° 41'$, corresponding to $a:b:c = 0.930:1:0.509$.

It was found best to recrystallize this alkaloid from ethyl acetate until the melting point became constant at 153° (Grimaux[10]). Fine crystals 2 mm. in diameter were finally obtained, which were measured, with the results shown in table 2.

TABLE 2. Angle Table for Codeine

Rhombic, bisphenoidal; $a:b:c = 0.931:1:0.509$[a]

Number	letter	Symbols G'd't	Mill.	Description	Observed φ	Observed ρ	Calculated φ	Calculated ρ
1	*b*	0∞	010	Narrow; often absent	......	......	0°00′	90°00′
2	*a*	∞0	100	Prominent form	90°00′	90°00′	90°00′	90°00′
3	*m*	∞	110	One prism form	47°00′	90°00′	47°03′	90°00′
4	*n*	∞2	120	Another prism form	28°15′	90°00′	28°14′	90°00′
5	*q*	01	011	Small; often absent	......	......	0°00′	26°59′
6	*d*	10	101	Dominant terminal form	90°00′	28°40′	90°00′	28°40′
7	*p*	1	111	Well developed, sphenoidal, both + and —	47°00′	36°45′	47°03′	36°46′

[a] As with morphine the measurements vary ±20′, so axes are given to but three places.

The form above described, which we have found to separate also from absolute ether and methyl and ethyl alcohols, is evidently the same as that described by Arzruni.

The marked solubility shown by this alkaloid has permitted only rough measurements of the refractive indices as: $\alpha = 1.62$, $\beta = 1.63$, $\gamma = 1.65$, $\gamma - \alpha = 0.03$. The axial angle 2E is very large, about 125°; the sign +; and the dispersion strong, with $2E_r > 2E_v$. These agree with the data of Arzruni.

CODEINE MONOHYDRATE, $C_{18}H_{21}NO_3.H_2O$

At least six different authors have studied this form of codeine; and their results have been tabulated and discussed by Heydrich.[11] The forms which have been observed are the base, a prism with $\varphi = 45° 50'$ to $46° 15'$; two side domes with $\rho =$

[9] Zeitschr. Kryst. Min. 1: 302. 1877.

[10] Ann. chim. phys. (Ser. 5) 27: 274. 1882.

[11] Zeitschr. Kryst. Min. 48: 270. 1910.

22° 35′ to 22° 52′ for one, and 39° 12′ to 40° 02′ for the other; and a front dome with ρ = 40° 46′ to 41° 04′. The prism and the steeper side dome are taken as the unit forms. For the present study crystals were grown from water and from hydrous methyl alcohol, attaining a diameter of 2 mm. The results were:

TABLE 3. ANGLE TABLE FOR CODEINE MONOHYDRATE

RHOMBIC; PROBABLY BISPHENOIDAL; $a:b:c$ = 0.960:1:0.830[a]

Number	letter	Symbols G'd't	Mill.	Description	Observed φ	Observed ρ	Calculated φ	Calculated ρ
1	*c*	0	001	Narrow, often absent	......	0°00′	......	0°00′
2	*m*	∞	110	Dominant form	46°10′	90°00′	46°10′	90°00′
3	*k*	0½	012	One terminal form	0°00′	22°35′	0°00′	22°32′
4	*q*	01	011	Another terminal form	0°00′	39°40′	0°00′	39°42′
5	*r*	10	101	Observed by Heydrich	......	......	90°00′	40°51′

[a] The crystals were somewhat better in this case than in the two preceding ones, and the maximum variation was but ±10′, but previous results have varied so markedly that only three decimal places are used for the average axial ratios given.

The agreement between these results and the average of those of previous authors is close.

Codeine monohydrate has been described optically by Kley,[12] by Heydrich[13] and by Wright.[14] The measurements by the first and last of these authors are admittedly only approximate, because of the solubility, but Heydrich's measurements were made by the prism method, and are more accurate. The immersion method gave on our material roughly α = 1.54, β = 1.64, and γ = 1.69, $\gamma - \alpha$ = 0.15; axial angle 2E very large, around 130°; sign —; and dispersion distinct, with $2E_r < 2E_v$.

CODETHYLINE, MORPHINE ETHYL ESTER, MONOHYDRATE

$C_{19}H_{23}NO_3.H_2O$

The ethyl ester of morphine, the hydrochloride of which is known commercially as dionin, has apparently never been measured crystallographically.

[12] Loc. cit.

[13] Loc. cit.

[14] Loc. cit.

Some commercial dionin was dissolved in water, and ammonium hydroxide added to precipitate the alkaloid. This was extracte d

TABLE 4. ANGLE TABLE FOR CODETHYLINE MONOHYDRATE

RHOMBIC, PROBABLY BISPHENOIDAL; $a:b:c = 1.454:1:0.789$[a]

Number, letter		Symbols G'd't	Mill	Description	Observed φ	ρ	Calculated φ	ρ
1	*b*	0∞	010	Narrow; cleavage direction	0°00′	90°00′	0°00′	90°00′
2	*n*	2∞	210	One prism form	54°00′	90°00′	53°59′	90°00′
3	*m*	∞	110	Another prism form	34°30′	90°00′	34°31′	90°00′
4	*k*	0$^{1}/_{2}$	012	Narrower dome	0°00′	21°30′	0°00′	21°32′
5	*q*	01	011	Dominant terminal form	0°00′	38°15′	0°00′	38°16′
6	*d*	10	101	Well developed	90°00′	28°30′	90°00′	28°29′

[a] The maximum variation of ±20—observed renders the axial ratios uncertain beyond the third decimal place.

by ether, and recrystallized from this solvent until the melting point became constant at 83°.

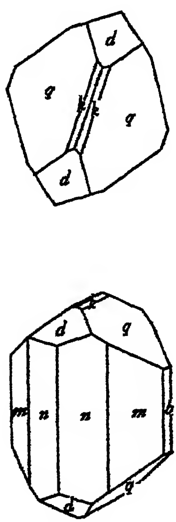


Fig. 1.—Codethyline

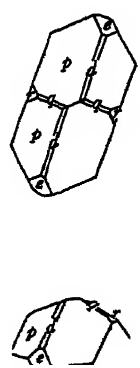


Fig. 2.—Heroine

The crystals obtained from ether containing a little water reached a diameter of 5 mm., and were measured, with the re-

sults presented in table 3 and in Fig. 1. The orientation adopted is that which brings out the relationship between this substance and the two previously described monohydrates.

The immersion method yielded the following approximate data for these crystals: Refractive indices $\alpha = 1.55$, $\beta = 1.58$, $\gamma = 1.65$, $\gamma - \alpha = 0.10$; axial angle very large, about 125°; sign +; dispersion distinct, with $2E_r > 2E_v$.

HEROINE, DIACETYL-MORPHINE, $C_{21}H_{23}NO_5 = C_{17}H_{17}NO(CH_3COO)_2$

The commercial alkaloid was recrystallized until a product with a constant melting point of 171–172° was obtained. (Various authors give from 169 to 173°.) It was found to crystallize well from ether, ethyl acetate, and methyl alcohol. No crystallographic description of this substance could be found in the literature, so four of the excellent crystals obtained from ethyl acetate were submitted to measurement, with the results presented in table 5, and Fig. 2.

TABLE 5. Angle Table for Heroine

Rhombic, Bisphenoidal; $a:b:c = 0.8952:1:0.497$[a]

Number	letter	Symbols G'd't	Symbols Mill.	Description	Observed φ	Observed ρ	Calculated φ	Calculated ρ
1	*b*	0∞	010	Dominant form	0°00′	90°00′	0°00′	90°00′
2	*a*	∞0	100	Narrow, yet well marked	90°00′	90°00′	90°00′	90°00′
3	*n*	2∞	210	Narrow prism form	65°55′	90°00′	65°54′	90°00′
4	*m*	∞	110	Dominant prism	48°10′	90°00′	48°10′	90°00′
5	*q*	01	011	Narrow but definite	0°00′	26°30′	0°00′	26°28′
6	*r*	02	021	Very small	0°00′	45±	0°00′	44°53′
7	*d*	10	101	Narrow, yet well marked	90°00′	29°07′	90°00′	29°06′
8	*e*	20	201	Small but definite	90°00′	48±	90°00′	48°03′
9	*p*	1	111	Dominant terminal form; both + and — sphenoids	48°10′	36°45′	48°10′	36°45′

[a] The crystals of this alkaloid were more perfect than those of any of the others, and the maximum variation on angles was but ±5′, the probable error of any one measurement being ±1′. This permits statement of the axial ratios to the fourth place.

The crystals obtained from other solvents showed the more prominent of these forms, and the angles agreed within half a degree.

The optical properties obtained by the immersion method are as follows: Refractive indices: $\alpha = 1.56$, $\beta = 1.60$, $\gamma = 1.61$, $\gamma - \alpha = 0.05$; the maximum and minimum indices are usually

seen on the plate-like crystals; the optic axial plane being parallel to the surfaces of the plates, no interference figure is visible in most cases, but when flakes are broken across and tilted up, partial figures can be seen, the axial angle 2E being large, about 110°; sign —; and dispersion strong, with $2E_r > 2E_v$.

On comparing the axial ratios of these alkaloids, it is at once seen that there are certain relationships among them, and it seemed of interest to calculate and compare their topic axial ratios. For this purpose their specific gravities were determined approximately by suspension of clear crystals in mixtures of sassafras oil and small amounts of bromoform, a combination selected because it was found to attack the substances but slowly; and the gravity of the liquid in each case was then measured by a Westphal balance. The results are presented in table 6.

TABLE 6. Topic Axial Ratios of the Morphine Alkaloids Studied

Name	Compound of morphine	Crystallographic axes a	c	Mol wt. W
Morphine	...... + $1H_2O$	0.499	0.927	303.2
Codeine	methyl ester	0.931	0.509	299.2
Codeine	methyl ester + $1H_2O$	0.960	0.830	317 2
Codethyline	ethyl ester + $1H_2O$	1.454	0.789	331 2
Heroine	diacetyl deriv.	0.895	0.498	369.2

Name	Compound of morphine	Sp gr. P	Sp vol. V=W/P	Topic axes χ	ψ	ω
Morphine	...... + $1H_2O$	1.32	229.7	3.95	7.92	7.34
Codeine	methyl ester	1.32	226.7	7.28	7.82	3.98
Codeine	methyl ester + $1H_2O$	1.31	242.1	6.45	6.72	5.58
Codethyline	ethyl ester + $1H_2O$	1.29	256.7	8.83	6.07	4.79
Heroine	diacetyl deriv.	1.32	279.7	7.66	8.56	4.26

The topic axial relations exhibit certain interesting features, and permit of determining in which direction in the crystals substitutions or additions occur. Thus, comparing anhydrous codeine with its monohydrate, it is seen that the addition of the water takes place in the vertical direction, producing a 40 per cent increase in axis ω while χ and ψ both decrease about 15 per cent. Comparing the three monohydrates, of morphine and of its methyl and ethyl esters, it comes out with equal clearness that the CH_2 groups enter along the front-back axis, for the value of χ increases 50 per cent from morphine to its methyl ester, and 40 per cent more from the methyl to the

ethyl ester, the other two axes showing decreases of 15–20 per cent in each case. Comparison of the diacetyl derivative with morphine itself would show significant relations only if the anhydrous form of the latter were available; but on comparison with anhydrous codeine, the monomethyl derivative, it is seen that all three axes of the acetyl compound are about 10 per cent longer than those of the methyl derivative, showing that the acetyl groups produce their greatest increase in direction *a*, but at the same time expand the structure somewhat in both of the other directions. It is thus possible by this method to throw some light on the positions of the chemical molecules in the crystals of these substances.

GEOLOGY.—*Present tendencies in geology: Sedimentation.*[1] EUGENE WESLEY SHAW, U. S. Geological Survey.

Interest in sedimentation has both direct and indirect practical bearing. The economic value of this interest may lie for the most part in the future, but should nevertheless be definite and certain. We wish to know how geologic strata were formed. The more we learn about processes and their results the more we find there is to learn, and the more the field widens and apparent complexity increases the more fascinating becomes the subject.

The main needs felt are (1) a better understanding of the deposits of past ages; (2) a wider knowledge and better understanding of the processes now in operation and of their results, as seen in the distribution of sediments, and the form of depositional surfaces—submarine, sublacustrine, subfluvial, subaerial, and subglacial; (3) the ability to apply our knowledge to economic problems the solution of which may rest on the nature of ancient strata and the processes of their deposition, or on similar data concerning present-day deposits. It can be demonstrated that knowledge of sedimentation may reduce the costs of finding the mineral treasure of the sedimentary basins, of harbor improvement, of fish culture, etc.

A knowledge of sedimentation involves a study of the processes and immediate results of deposition; the source of sediment and

[1] Presented before the Geological Society of Washington, May 28, 1919.

its transportation; and the processes which modify strata and their component materials after they are laid down. The term sedimentation should cover these related matters, else another term is needed, for it seems impracticable to isolate these three branches of investigation.

The interpretation of a layer of sediment may involve the examination of the parent rocks or organisms or solutions from which it was derived and a study of the transporting agents that brought it to its present position. It may be possible occasionally to trace ancestry back through several generations of strata but the numbers of individuals in each preceding generation usually show an increase more rapid than the usual biologic ratio of 2, and one is soon lost in a maze which generally obstructs attempts to trace lineage back to the ancestral igneous and metamorphic rocks.

It is rather curious that although the problems of sedimentation are relatively simple, advances in the science, in the opinion of some, have been of a slow and halting nature. The temperatures and pressures involved in processes of sedimentation are of a low order compared with those concerned in the study of igneous rocks. One or more of the processes are everywhere in operation; many of them can be reproduced in large part, some with simple apparatus; and the deposits themselves are fully exposed to view and ready for inspection and sampling.

Apparently there have been and will continue to be two general ways of making progress in knowledge of sediments: One is through contributions from geologists in general and paleontologists in particular, who gather facts and formulate ideas in the course of their other work. For example, A. C. Veatch observed impressions of upright trees and, with the associated stratification, interpreted a formation as made up of sand dunes. Stephenson suggests that pebbles worn to disc or oval shapes indicate wave action on a beach. Ulrich has outlined the general conditions of deposition of various formations. The other method is by special deductive or inductive field, laboratory or closet studies of selected sediment problems. Up to date there have been many contributions to the first class; to the second, few.

Notwithstanding the fact that advances have been made, there is as yet no adequate systematic classification that is generally acceptable. There is not even a satisfactory nomenclature.

There are many features of sedimentary deposits that are not understood and are passed unexplained. Concretions, clay balls, mud pebbles, quicksand, singing sand and a large number of less common nameless features are familiar but not thoroughly understood. There are also, for example, extremely interesting problems concerning the development of beaches, the conditions that control the amount of wave erosion which a subsiding land undergoes, and so on. One may assume that wave erosion is most vigorous at the seaward end of a peninsula that is bordered by deep water. Yet the offshore slopes both at the south end of the Florida peninsula and off the mouths of the Mississippi are above average, whereas wave erosion is below the average. At the mouths of the Mississippi the average offshore slope is about 60 feet to the mile, yet houses built on piles whose tops are 4 to 6 feet above sea level are reasonably safe even in a West Indian hurricane.

Progress in deciphering the processes of sedimentation is difficult; the quantity of data and number of working hypotheses to be borne in mind are legion. Lack of progress has been due not only to neglect and oversight but to inherent difficulties. A review of a piece of work in sedimentation is likely to call forth the remark, "Fundamental problems are still unsolved." Too much must not be expected from little expenditure of energy. It is equally true that coordination of effort is necessary for the best results.

We must admit that we can see only dimly the conditions under which many of our most familiar formations were laid down. We cannot yet write the equation for the reaction which in Nature's laboratory produced the St. Peter sandstone. We can, of course, write: a supply of sufficiently coarse-grained material exposed at the surface + suitable agents operating in the right direction for its transportation + land of suitable surface configuration and altitude + disposal by some means of all other freight carried by these agents + wind or some other work to

round and frost the grains + a transgressing sea to redistribute the sand without introducing any more mud than the formation contains, and so on; but at the end we would still have a very poor idea of the conditions of deposition. Indeed if each known element in the equation were fully understood and were reproduced we probably should not get another St. Peter sandstone, and possibly the result would only remotely resemble it.

The Devonian black shale, the great coal beds with their persistent thin partings, the wide spread sandstones, such as the Dakota and Berea, the oolites, the so-called "Lafayette formation," and a great many others are still more or less matters of mystery. We are inclined to make remarks of satisfaction such as that we were formerly misguided regarding a certain formation but that we know better now,—we understand the conditions of its deposition; we used to think, for example, that coal is a product of tropical climate; now we know that it is formed under temperate or cool temperate conditions. But is there not still a great gulf between the relatively small and rarely smothered peat bogs upon which our assumed understanding of coal rests and those great expanses of peat swamp which developed over a sinking and frequently flooded land?

It seems to me that after all, we know for most strata only the main features of their conditions of deposition. We do not know whether the surficial sand and gravel deposits of the Atlantic Coastal Plain are mainly marine or mainly fluviatile, and this, notwithstanding the fact that all are geologically recent and some very recent formations. Various criteria become obscure with age and in particular the related physiographic features are gradually wiped out. Yet here in spite of youth and more or less perfect preservation of several kinds of physiographic features we are still groping in the dark, and are fortunate if we are able to avoid the pitfall of jumping at conclusions.

Vaughan[2] says: "It is generally agreed that the soundest basis for inferring the condition under which past sediments were formed and deposited is to be obtained through a study of pres-

[2] Unpublished memorandum to National Research Council.

ent-day sediments and sedimentary processes and that as great a diversity of phenomena as possible should be investigated." In the report of the Petrologists' Club committee on sedimentary rocks[3] it is stated that "The main object of petrologic descriptions of sedimentary rocks is evidently the interpretation of sedimentary records, though such descriptions should be useful also for identification, classification, economic purposes, and miscellaneous reference."

The need of carefully recorded descriptions of the physical characteristics of ancient sediments is especially worthy of emphasis. We have as yet no adequate color scale and statements concerning texture are usually only the crudest approximations. In geologic field work the proportions of various sizes of grains are rarely determined. The term "porosity" is used promiscuously for "total volume of pores," for "size of pores" and for "perviousness"—entirely distinct concepts. Mineralogic or chemical constitution is rarely determined in detail;—our classic table of average chemical composition of sedimentary rocks is, I believe, defective;[4] and shape of grains in noted only occasionally.

Methods of collecting specimens are much in need of standardization. Many samples represent a considerable thickness of strata—from a few inches to a foot or more,—within which more or less difference in conditions of deposition may occur. The resulting complexity in the sample greatly reduces the value of any mechanical analysis.

Though already recognized, the fact is still worth pondering that the bulk of our knowledge of sedimentation has come more or less inductively from the study of sedimentary rocks, conditions of deposition being inferred from general principles of physics and chemistry. Studies of present-day agents, processes, and kinds of deposits would furnish a much better foundation, though admittedly such studies would not be complete, because the conditions of deposition of most strata, particularly as to areal extent and also in other respects, are not fully represented anywhere at present.

[3] Mimeographed report signed by M. I. Goldman, D. F. Hewett, G. S. Rogers, and E. W. Shaw.

[4] Shaw, E. W., *Sulphur in rocks and in river waters.* This Journal 5: 484. 1915.

We sometimes feel that the general arrangement and distribution of deposits on lake and sea floors is fairly well known, yet the only detailed areal survey of any considerable portion of the sea floor—that made by Thoulet in the Gulf of Lyons—leads to a map that no physiographer or stratigrapher could have produced in advance.

Accurate surveys of selected areas of ocean and lake floor are greatly needed; areas not far off shore are of especial interest because of their economic bearing and because here there is greatest variety in process and nature of deposit. Contributions of this sort have already been made by Kindle for certain of the Great Lakes and by Vaughan for waters off the coast of Florida. Inductive work along the same line has been done by many geologists, among the foremost of whom is that eminent geologist of Lehigh and Yale whose loss we are now feeling so keenly. Experimental work has been done by a few, the most noteworthy being perhaps that of Gilbert[5] and Engels.[6]

Not only is there need of increase in the knowledge of sediments but there is need of dissemination of the knowledge heretofore gained. Some of the discoveries already made are not serving as they might. It has been shown that corals contribute little to accumulation of sediments and yet some still speak of coral islands and coral limestone in a way that indicates a misconception. We speak of clastic, chemical, and organic deposits, forgetting that limestones are generally clastic: are composed of fragments, now more or less extensively recrystallized, that were transported on the average thousands if not tens of thousands of feet. We interpret a great many sand lenses as fossil beaches, forgetting that shore deposits are as a rule ephemeral.

Although the study of sediments has lagged behind other branches of geology, real progress has been made in a number of problems. It is worthy of note that most of this progress has been made by men engaged primarily in other lines of science, by men

[5] GILBERT, G. K. *The transportation of debris by running water.* U. S. Geol. Survey, Prof. Paper 86. 1914.

[6] ENGELS, H. *Fluss-Strecken mit beweglicher Sohle.* Zeits. für Bauwesen. 1905.

who have either made valuable observations in connection with other work or who have dropped their other work for a time while they undertook a special study of sediments.

Especially noteworthy advances in the study of present-day sediments have been made during the last decade or two. Murray and others have collected much information concerning the great ocean deeps. Thoulet gave us a detailed map showing the areal distribution of sediment over a portion of the sea floor. Engels experimenting with an artificial stream analyzed processes of alluviation. Gilbert deduced, from a series of experiments, certain fundamental laws concerning fluviatile transportation of sand and gravel.

Barrell gave us a philosophical discussion of the conditions and processes involved in the accumulation of littoral deposits. Kindle has observed and recorded diagnostic features of various kinds of deposits. Udden has presented the results of many years of study of the mechanical constitution and peculiarities of the main classes of sediments. Goldman has given us the results of his investigations of sources of certain sediments and the diagenesis of others.

Recently T. W. Vaughan has put into operation a plan for coordinating the energies of those principally interested in sediments, and in response to his request they have submitted memoranda which have been transmitted to the National Research Council. The main feeling behind the movement is expressed in Vaughan's memorandum in the following words: "As the factors entering into both the origin and deposition of sediments are so diverse and so widely distributed it is impracticable for any one man, any small group of men, or any organization whose activities are really limited to cover the field."

Some quotations from the replies will be of interest. Barrell, obviously impelled mainly by his interest in earth history, says by way of introduction to his "*Project for a study of sedimentation*," dated January, 1919:

"If the interpretation of the climatic and physiographic history of the earth, as based on the nature of the sedimentary rocks, is to progress along lines now opened up, it is neces-

sary that comprehensive systematic studies of modern sedimentation be undertaken from this interpretative standpoint. Such men as Lyell and De la Beche made a good beginning, but the present problems of earth history were beyond their horizon, and the older studies of sedimentation were, furthermore, general in character and descriptive of the thing in itself rather than of its significance. The idea of the necessity for criteria for the discrimination of various climatic and physiographic controls in the making of ancient sediments was until recently a point of view not conceived."

Blackwelder says that because of his interest in the earth's physical history and his experience with sedimentary rocks he has been "especially impressed with the advantages to be gained from painstaking study of the consolidated formations" and in particular their lateral variations. He suggests "the exhaustive study of individual types or type groups of sediments in both modern and lithified state."

Kindle is especially interested in lake and sea bottom deposits, in ripple marks, in migration of shores and transportation of littoral deposits, etc. Steiger and Wells present an outline of needed and practicable chemical and physico-chemical work. Others have contributed valuable suggestions.

SUMMARY

Although to progress in the understanding of sediments is somewhat difficult the need is real. Much can be accomplished through coordination, through getting geologists of all lines to give some attention to the subject, and through carefully considered and well executed special plans. Apparently the trend of thought at the present time is in harmony with the needs. Some assistance has already been rendered and more is planned by specialists in other lines. Physicists, chemists, biologists, and others are ready to study marine deposition, the bottom loads of rivers, cementation, dolomitization, problems connected with the origin and accumulation of petroleum, and the geophysics and geochemistry of the great sedimentary basins. Physiographers and climatologists will make their contributions.

It is hoped that a sediment laboratory may be equipped and operated in the Geological Survey. In this laboratory many kinds of petrologic investigation should be carried on. Mechanical analyses of specimens of various present-day and ancient deposits and studies of mineralogy, porosity, specific gravity, and shape of grain will be undertaken. It is hoped also that a useful collection of sediments and sedimentary rocks may be built up, as was planned by Hayes, Lindgren and others. The work should be pushed without extravagance but with vigor.

What contributions we may expect from field work on sediments now in process of accumulation is not definitely known, but no doubt studies will be made of certain such deposits. In the Florida Keys, for example, this may involve continued research on the composition of sea water and the questions of whether or not this water is saturated with carbonate of lime and whether cementation of the shell and other fragments may take place below sea level.

During the last decade there has, I believe, been some increase of interest in the study of sediments. Although during the war investigations were checked, there is at the present time, I hope, and am inclined to believe, an increasing interest in the science and a tendency toward cooperation which will lead to fruitful investigations.

ANTHROPOLOGY.—*Some general notes on the Fox Indians. Part II: Phonetics, folklore and mythology.*[1] TRUMAN MICHELSON, Bureau of American Ethnology.

FOX PHONETICS

I have elsewhere[2] briefly discussed the chief differences between Jones' scheme of Fox phonetics and my own. There are a few points that should be taken up here. The most important one is that before an initial consonant of a following word a terminal voiceless aspirated vowel of the preceding word becomes full-sounding and loses its aspiration. As terminal voiceless aspirated vowels are normally lost before initial vowels and diphthongs,

[1] Published with the permission of the Secretary of the Smithsonian Institution.
[2] Internat. Journ. Amer. Ling. 1: 54.

it will be seen that they are strictly only proper when a break in sense occurs. Unfortunately it was not possible to teach informants to dictate the words this way. It depended on the length of words as to whether I could take more than one at a time; and in this way the resulting texts contain mixed sentence-phonetics. The choice therefore remains of printing texts with these inconsistencies or making the phonetics uniform. It seems correct to do the latter so far as sentence-phonetics are concerned. In this normalization I have chosen the full-sounding terminal vowels before initial consonants, save where the sense indicates a pause; before initial vowels and diphthongs terminal voiceless aspirated vowels are eliminated. In this matter I have been guided not only by the fact that in this way a truer picture of the language is presented, but also because in so doing complicated symbols are avoided: thus -*m*$^{m\text{A}}$‘ is eliminated in favor of -*m*A and -*m*, and so on. The elimination of terminal voiceless aspirated vowels before initial vowels and diphthongs is to a certain extent at least a question of tempo; in actual Fox speech I have heard them even as full-sounding in this position. The texts accordingly represent allegro tempo. Even final full-sounding vowels are aspirated before an initial sibilant. Another point may properly be brought up. Within verbal complexes the elision of final *i* of one morphological element before another such element beginning with a vowel or diphthong, especially in "loose composition," is to a certain extent a matter of allegro or lento tempo. I have followed the usage of the reciter of the texts. It may be noted that in the current syllabary the Foxes are not consistent in writing or omitting such a vowel; yet in "loose composition" the vowel is written for the most part, and elided in intimate compounds. It should be remarked that the Meskwakis themselves in such cases very frequently separate the elements by periods. The principal word accent is indicated by the acute (′). Following the recommendations of the committee of the American Anthropological Association[3] I have employed the symbols and

[3] *Phonetic transcription of Indian Languages*, Smiths. Misc. Coll. 66, No. 6: 1.

general scheme of Dr. Jones in the matter of things phonetic save where in my judgment they are inadequate.

The following table will show the phonetic elements of Fox as I conceive them:—

Vowels and diphthong

Full-sounding:

a A *e* *i* *o* *u*
ā *â* *a* *ē* *ī* *ō*[4]

(*ē* never occurs save terminally as a rhetorical lengthening of *e* or *i*, and then has an *i*-vanish; *ō* when a terminal rhetorical lengthening similarly has a *u*-vanish; *â* is found only after *w*).

ai (only before *y*),

an (only in the exclamation *ʿau'*).

Voiceless and aspirated (terminally only):

Aʿ *a*ʿ *e*ʿ *i*ʿ *o*ʿ

Consonants

	Stops	Spirants	Affricatives	Nasals	Semi-vowels
Glottal	ε	ʿ	..	..	..
Palatal	*k* ʿ*k* *g* g^k	..		.	y^y
Alveolar	..	*c* ʿ*c*	*tc* ʿ*tc* ^{d}*tc*	.	..
Dental	*t* ʿ*t* *d*	*s* ʿ*s*	.	n^n	..
Labial	*p* ʿ*p* *b*	..	..	m^m	w^w

The sibilants *s* and *c* occur only initially; otherwise they are replaced by ʿ*s* and ʿ*c*, respectively. The spirant ʿ after back vowels is nearly intermediate in effect between a surd velar spirant and our *h*; after front vowels the effect is more palatal. It always occurs before initial vowels and *ai*. The stops *g d b* are articulated with greater strength than in English; they never occur initially; before terminally voiceless vowels *g* becomes g^k; *d* and *b* (both of which are rare, especially the former) do not occur in final syllables. Voiceless ^{n} ^{m} ^{y} ^{w} are phonetic modifications of *n m y w*, respectively, before terminal voiceless vowels. The affricative ^{d}*tc* occurs initially and medially save in final syllables; ^{d}*tc* occurs mostly in final syllables, though also in medial ones. It may be noted that ʿ*k* ʿ*t* ʿ*p* ʿ*tc* are given as a series, because (outside of verbal compounds after ʿ*ā*-, *nī*-, *kī*-, *wī*- where they are transformations of *k t p tc*) they correspond in Cree to a sibilant followed by *k t p tc*. It may be added that

[4] *ä e i u* are open; *ī ō* are close.

'p 't and *'tc* never occur in terminal syllables nor initially. The surd *k t p tc* are unaspirated; *k p tc* never occur in terminal syllables.

To forestall hasty criticism it should be said that the differences in the quantity and quality of the vowels in such words as *'ī'wᴬ'* "he said," *'a'i'ᵈtcı'* "then he said;" *'ugimā'ʷᴬ'* "chief," *'utōgimānıwāwᴀn* " "their chief;" *pemipa'ō'ʷᴬ'* "he runs by," *pemipa''owᴀgᵏ'* "they run by," *nepemipa''ᵘ'* "I run by," *'a'pemi'pa'uᵈtc'* "when he ran by;" *nenī'ʷᴬ'* "man," *ne'niwᴀnⁿ'* (obviative of the same), *neniwᴀ'gᵏⁱ'* "men;" *ne'sᴀnᴀgi''tⁿ'* "I had difficulty with it," *sᴀnᴀge'sīʷᴬ'* "he is incorrigible" are true phonetic processes and are not merely due to mishearings.[5] I have had abundant opportunity to test these again and again to be sure that there was no error in apperception; and Mr. J. P. Harrington (of the Bureau of American Ethnology) also agrees that these differences are truly phonetic and not merely auditory. The phonetic laws governing these shifts have not been determined, but it is clear that the position of the accent and the nature of the adjacent sounds are in a large measure responsible for the phenomena. The influence of the last are responsible for the different results seen in the contractions[6] in *nekī'ci'tā'gᵏʷᴬ'* "he made it for me," *kekī'ci'tō'n ᵉ'* "I made it for thee" as compared with *kekī'ci'ta'wipen ''* "you made it for us," *kī'ci'tawa''ʷ'* " he made it for him." It is in the belief that some time it may be possible to enunciate phonetic shifts with accuracy that certain apparent fluctuations have been allowed to stand. Thus for example the fact that *â* never occurs except after *w*, and never in penultimate syllables suggests that it is a modification of *ā* due to the influence of the neighboring sounds, including following ones. The fact that *a* never occurs in penultimate syllables though both *ā* and ᴀ do,[7] tends to show a phonetic shift or shifts have taken place. Hence it is well to be conservative in holding that cases where *a* and ᴀ

[5] This will be shown in a future number of the *International Journal of American Linguistics*

[6] See this Journal, 9: 333

[7] Neither does it occur before *'k, 't, 'p, 'tc, 's, 'c*. Where Jones records *a* in such cases I hear ᴀ Similarly I hear ᴀ for *a*, and ᴀ' for *a*.

apparently interchange medially are merely mishearings. The limitations of the positions of certain consonants (see above) likely enough are in part due to phonetic shifts; some are certainly due to these. The evidence of cognate dialects favors the view, but this is not the proper place to discuss this aspect in detail. In conclusion it may be noted that *ck*, *'ck* are the only true consonantal clusters in the language. The cluster *st* is found in English loan-word *'i'stakinʌ'nᵐ'* "stockings."[8] According to William Jones *stc* occurs in an exclamation.

FOX FOLKLORE AND MYTHOLOGY

The time for a final discussion of Fox folklore and mythology is hardly ripe. For comparative purposes the data are too meager. We are practically without any Sauk material, the Kickapoo published (Jones) and unpublished (Michelson) collections are inadequate; the published Potawatomi material is negligible, and that unpublished (Skinner, Michelson) is probably insufficient; the unpublished[9] material of Peoria folklore and mythology (Gatschet, Michelson) is adequate, the published Cree, Algonkin, and Ottawa collections are deficient; the published Menominee material is adequate; the published and unpublished (Jones) material of Ojibwa folklore and mythology is extremely extensive; and so is that of Fox, especially the unpublished portion (Michelson). So that even a comparative study of the folklore and mythology of only Central Algonkins would be very one-sided. When the inadequate published data from such Siouan tribes as the Iowa, Winnebago, and Osage are taken into account, it will be seen that a truly comprehensive study of Fox folklore and mythology is, for the present, quite out of the question. Happily there is plenty of unpublished Winnebago material (Radin), and possibly Iowa (Skinner), so that in the near future conditions may be distinctly improved. At the present time the only adequate collections of Siouan folklore and mythology are from the Assiniboine, Crow, and Omaha; the published material of the Sioux proper is insufficient.

[8] Also in a couple of other loan-words.

[9] See now MICHELSON, Journ Amer. Folk-Lore 30: 493–495.

The late Professor Chamberlain[10] undertook a brief comparative study of the myth of the culture-hero among Central Algonquian tribes, but the Sauk and Fox material available at that time seems to have escaped him; and it must be said in justice to him that it was not readily accessible. The paper by the late J. Owen Dorsey,[11] should be read in connection with Professor Chamberlain's article. Some years later Professor Dixon[12] published a comparative study of the mythology of Central and Eastern Algonkins. As he was able to use the Fox collections of Jones, his paper is of importance to us. Unfortunately his sources are not given, nor are the mythologies of the plains Indians used in his study. Nevertheless this article is very useful as a stepping-stone. The essential points which Dixon seeks to establish as regards Fox folklore and mythology are: (1) Fox has one set of non-culture-hero incidents with Menominee, and another with Cree-Ojibwa; (2) Fox shares with Ojibwa but few such incidents in common with the Eastern group, though both, especially Ojibwa, have a number of such incidents with this group; (3) Fox has a number of elements which are typically Iroquoian; (4) Fox and Potawatomi form a special group among the Central Algonquian tribes. Additional material, published and unpublished, since 1909, shows that these theses will have to be somewhat modified. I have gone over Barbeau's *Huron and Wyandot Mythology* and find that with one possible exception Fox has not a single incident in common with Huron-Wyandot which is not shared with some other Central Algonquian tribe. And my unpublished Potawatomi material, which, though inadequate, is far greater in extent than that published, tends to show that the fourth thesis is wrong. Fox folklore and mythology is treated but incidentally by Dr. Radin in his *Literary aspects of North American mythology*, but it should be stated that on page 8 he has confused the Fox and Menominee versions of the cycle of the death of the culture-hero's younger brother. The general subject of the

[10] Journ. Amer. Folklore 4: 193–213.

[11] Ibidem 5: 293–304, "*Nanibozhu in Siouan Mythology.*"

[12] Ibidem 22: 1–9 [Jan.–March, 1909].

mythology and folk tales of North American Indians is treated by Boas.[13]

I have spoken above of my unpublished collection of Fox folklore and mythology. This consists of several thousand manuscript pages written out by Indians themselves. It should be mentioned that even the stories previously published by Jones have an entirely distinct literary style in this collection. I presume this is due to the difference in the method of collecting the material. However, it must not be assumed that all my Fox myths and tales are of a single style. Indeed, on the basis of style alone it would be possible to refer many to their respective authors. For example, informant A is extremely prolix, and fond of detail; informant B is brief, but lugs in the rolling-skull episode on every possible occasion; informant A is a skillful narrator and the tale runs along smoothly and with artistic effect; informant C is unusually awkward; though his tale may contain every incident in the corresponding story of informant A, nevertheless there are distinct breaks in the narrative, and so his tale could not be printed without patching up these portions, however valuable it might be for linguistic purposes or for a control of the myths and tales of others. A question I hope to take up at a future date is the choice of words and phrases among different informants.

As to the contents of the above collection. A large percentage of the myths and tales in Jones' Fox Texts has been duplicated; almost all of these occur with rather greater detail than in his collection; numerous other myths and tales, among them the Cosmic Myth, about 1,200 manuscript pages, of the type represented in his collection naturally have also been collected: the distinguishing features of my collection are the more numerous animal tales; many stories clearly of European origin; origin-legends of gentes; ritualistic origin-myths. I have previously pointed out some of the European cycles.[14] To these may be added a fox cycle of considerable length and another called "Tiger;" and it may be noted that Cosmic Myth (the story of Me'sᴀ'kᴀmigō'kwäwᴬ') has an enormous number of incidents

[13] Journ. Amer. Folklore 27: 374-410.

[14] Amer Anthrop., n. ser. 15: 699.

that are patently European. The French-Canadian collections by Barbeau in the *Journal of American Folklore* make it probable that Cā'kanā'ᴬ' is not a corruption of Jacques le but rather of Jacquelin. Skinner's statement[15] that "the Central Algonkin as a whole have not absorbed much folklore that is European" is not justified by the facts of Fox or Peoria tales I have made a brief study of Fox ritualistic origin myths.[16] The essential point is that thus far this particular type of ritualistic origin myths is unique owing to the profusion of information contained in them. The value of these myths for strictly ethnological studies has also been emphasized.

As said above, the time is not yet ripe for a final discussion of Fox folklore and mythology. Nevertheless an opinion based on the present materials may be of some value. Disregarding the origin-legends of gentes and ritualistic origin-myths[17] for the lack of comparative material, it is clear that Fox folklore and mythology is composed of woodland, plains, and European elements[18] The plains elements are firmly established by the distribution of the tales corresponding to the Fox story of how the culture-hero (Wɪ'sᴀ'kā'ᴀ') rolls himself downhill to catch turkeys, and the tale of his eating the artichoke; correspondents to the former occur among the Skidi Pawnee, Caddo, Biloxi, Alibamu, and Ojibwa (ducks secondarily); to the latter among the Menominee, Eastern Dakota, Assiniboine, Crow, Pawnee, Skidi Pawnee, Arikara, and Wichita. The occurrence of correspondents to the Fox story of the beaver and culture-hero among the Peoria, Ponca, and Shoshoni also points to the plains as a center of distribution. If I have emphasized the occurrence of plains-elements in Fox folklore and mythology, it is because hitherto the stress has been on the woodland-elements. From the materials available it would seem as if Kickapoo folklore and mythology on the whole are closest to those of Fox, and that Ojibwa folklore and mythology are rather remotely connected therewith.

[15] Journ Amer. Folklore 27: 100.

[16] This Journal 6: 209–211 1916

[17] The native term for such as refer to the festivals of the gentes is *kīganowi'āte' sō'kāgᴀnⁿᴬ'* (plural -*ᴀnᴀgᵏⁱ'*).

[18] Compare Amer. Anthrop , n. ser. 15: 699.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors The abstracts should conform in length and general style to those appearing in this issue.

GEOLOGY.—*Oxidized zinc ores of Leadville, Colo.* G. F. LOUGHLIN. U. S. Geological Survey Bulletin No. 681. Pp. 91, pls. 8, figs. 7. 1918.

Although deposits of oxidized zinc ores at Leadville, Colo., had been exposed in mine workings for many years previously, it was not until 1910 that their character and extent began to be realized. Since that year large quantities have been mined annually. Bulletin 681 begins with a review of early accounts of zinc carbonate and silicate and of the recent discovery of the ore bodies. It then describes in detail the oxidized zinc ore minerals and minerals associated with them, the varieties of ore, their range in metal content, their distribution and extent, and their genesis. G. F. L.

GEOLOGY.—*The evaporation and concentration of waters associated with petroleum and natural gas.* R. VAN A. MILLS and R. C. WELLS. U. S. Geological Survey Bulletin No. 693. Pp. 104, pls. 4, figs 5. 1919.

The widely observed association of saline waters with petroleum and natural gas is ascribed by the authors, at least in many cases, to deep-seated concentration brought about by evaporation into moving and expanding gas. During this concentration there is a definite order of change in the relative proportions of the dissolved constituents in the waters. Carbon dioxide and other gases are lost from solution. Calcium, magnesium, and iron separate from solution as carbonates, and, under favorable conditions, sodium chloride separates,—a process illustrated in the "salting up" of gas wells.

In discussing these changes the authors present evidence based on field studies as well as laboratory determinations, including the results of examinations of the rock specimens, analyses of the waters, the determination of the solubility of salt in solutions carrying calcium chloride, the vapor pressure of water in illuminating gas, and a résumé of the initial gas pressures in several gas fields. Elaborate compar-

isons are also given between the deep-seated Appalachian brines, sea water, and surface waters, intended to show the probable changes that have taken place in the oil and gas field waters. In short, the complete history of the waters is sketched, as nearly as it is possible to do so, from the time of their inclusion in the sediments to the present. Effects likely to be caused by changes in temperature and pressure such as it is reasonable to suppose may have affected the strata are pointed out.

Some practical applications of the principles and discussion are given. It is suggested that analyses of the waters in or near oil and gas fields may throw light not only on the location of the more valuable fluids, but also on the probable reactions and precipitations that might ensue when the different waters are allowed to mix either in the wells or in the strata. Careful consideration should also be given to the movements and rearrangements that the oil, gas, and water undergo incident to extraction. R. C. W.

GEOLOGY.—*Relations of Late Paleozoic and Early Mesozoic formations of southwestern Montana and adjacent parts of Wyoming.* D. DALE CONDIT. U. S. Geol. Survey Prof. Paper 120-F. 1918. Pp. 111–121, pls. 5, fig. 1.

This paper presents evidence found in southwestern Montana concerning the great Jurassic base-leveling and its bearing on the solution of certain stratigraphic problems involving late Paleozoic, Triassic, and Jurassic formations, and sets forth the relations of those formations to beds in western Wyoming. The conclusions briefly summarized are as follows:

Prior to the encroachment of the sea from the northwest in late Jurassic time prolonged erosion and base-leveling occurred over much of the Rocky Mountain region. From Idaho State line near Yellowstone National Park northward to the vicinity of Helena the erosion surface thus produced truncates beds of Triassic and Carboniferous age, through a stratigraphic range of about 1,000 feet.

The Quadrant quartzite at the type locality in the northwestern part of Yellowstone Park is approximately equivalent to the Amsden and Tensleep formations in Wyoming. The Park City (Pennsylvanian and Permian), Dinwoody (Lower Triassic), and Chugwater (largely Triassic) of the Wyoming section are in part represented by the Teton formation of Yellowstone Park. The quartzitic cherty basal beds of the Teton, containing the phosphate rock, are equivalent to the Phos-

phoria formation of Idaho, which corresponds to the upper part of the Park City formation. In western Montana north of latitude 45° 30′ the overlying Triassic shaly limestone and red shale were removed by the Jurassic erosion and the Ellis formation (Upper Jurassic) rests on the partly eroded Phosphoria formation. R. W. STONE.

GEOLOGY.—*Geology of northeastern Montana.* ARTHUR J. COLLIER. U. S. Geol. Survey Prof. Paper **120-B**. Pp. 17–39, pls. 6, figs. 5. 1918.

Describes a large thinly settled region in northeast Montana which is part of the Great Plains. The topography is discussed and formations from Cambrian to Jurassic exposed in Little Rocky Mountains are described briefly. The Cretaceous, Tertiary, and Quaternary formations are described more fully, and the geologic structure is explained. Drainage diversion due to the invasion of ice during the glacial epoch forms an interesting conclusion of the report. R. W. STONE.

GEOLOGY. *A contribution to the geology of northeastern Texas and southern Oklahoma.* LLOYD WILLIAM STEPHENSON. U. S. Geol. Survey Prof. Paper **120-H**. Pp 129–163, pls. 14. 1918.

This paper sets forth the present state of knowledge in the areal mapping, in the interpretation of structure, and in correlation, and indicates certain mappable units and structural features that have not heretofore been recognized in the region in central and northeastern Texas and southern Oklahoma known as the Black and Grand prairies. The area lies near the northwestern border of the Gulf Coastal Plain in northeastern Texas and southern Oklahoma, and is a dissected coastal-plain upland ranging in altitude from about 530 feet in the southeast to 850 feet in places in the northwest. The drainageways of the area present many good examples of consequent, subsequent, obsequent and perhaps other classes of streams.

The area is underlain throughout its extent by strata of Cretaceous age, which rest upon a buried, moderately smooth basement composed of ancient rocks. The tilted peneplained surface of the basement rocks dips to the south from the northern boundary at rates estimated to range in different places from 50 to 70 feet or more to the mile, and to the southeast from the western boundary at rates probably ranging from 40 to 50 feet to the mile.

The basement rocks are separated from the overlying Cretaceous deposits by an unconformity representing a long interval of geologic time, including at least the Triassic and Jurassic periods and probably a considerable part of the Lower Cretaceous epoch.

The Cretaceous deposits are divisible into two great series, a lower, the Comanche series, which appears at the surface about the flanks of the Preston anticline in the northwestern part of the area and has an estimated thickness of 800 to 1,000 feet, and an upper, the Gulf series, which has an estimated thickness of at least 3,000 feet and the outcrop of which covers considerably more than half the area. Each of these series is separable into subordinate divisions. The Gulf series is unconformably overlain by strata of Eocene age which appear at the southeast in a relatively small part of the area. In general the strike of the strata is parallel to the inner margin of the Coastal Plain, and the dip is coastward from this margin at rates ranging from 30 feet or less to 80 feet or more to the mile. A considerable departure from the prevailing regularity in strike and dip occurs in the northwestern and central parts of the area, in connection with the Preston anticline.

The Cretaceous deposits consist of sand, shaly clay, calcareous shaly clay, limestone, and chalk. Pleistocene alluvial terrace deposits largely conceal the Cretaceous formations in a broad area.

R. W. Stone.

GEOLOGY.—*Geology and ore deposits of the Yerington district, Nevada.* Adolph Knopf. U. S. Geol. Survey Prof. Paper 114. Pp. 68, pls. 5, figs. 12. 1918.

The Yerington district in western Nevada is, next to Ely, the most productive copper district in the State. The oldest rocks of the district consist of andesites, keratophyres, and limestone, with subordinate shale, quartzite, and gypsum, all of Triassic age. They were intruded in post-Triassic time, probably early in the Cretaceous, by granodiorite, which was followed by quartz monzonite. These intrusions intensely metamorphosed the rocks they invaded and converted large areas of them into lime-silicate rocks. After this metamorphism the region was cut by numerous dikes of quartz monzonite porphyry. Faulting then ensued, and along the faults ore-forming solutions rose and produced the copper deposits to which the district owes its economic importance.

The Tertiary rocks, resting with marked unconformity on the Mesozoic group, are chiefly volcanic and are at least 7,000 feet thick. They fall into three major groups which are separated by two well-marked unconformities. The lowest subdivision consists of quartz latite, rhyolite, and andesite breccia; and it is probably the correlative of the Esmeralda formation of Upper Miocene age. The middle subdi-

vision consists of andesite flows resting in places on the eroded edges of the rhyolites. The uppermost subdivision consists of subangular conglomerate overlain by basalt.

The principal ore bodies consist of pyrite and chalcopyrite in a gangue of pyroxene, garnet, and epidote. They are replacement deposits of limestone developed along fault zones and are of the contact-metamorphic type. The primary ore is essentially unenriched by later sulphides. The average tenor of the ore mined has ranged from 2.75 to 6 per cent of copper. A. K.

ANTHROPOLOGY.—*The Maya Indians of southern Yucatan and northern British Honduras.* THOMAS W. F. GANN. Bull. Amer. Ethnol. 64. Pp. 146, pls. 28, text figs. 84. 1918.

The Maya Indians will always be noteworthy as those who attained the highest cultural development in America, or at least in North America. A study of the living representatives of that race or of their antiquities is therefore doubly welcome and in the present bulletin we have both; Part 1 being devoted to the "Customs, Ceremonies, and Mode of Life" of the modern Maya and Part 2 to "Mound Excavation in the Eastern Maya Area." The former, covering 36 pages, considers the habitat, personal characteristics—including the material culture—and the social characteristics—including religion; the latter contains a short description of the ancient inhabitants of the region as revealed by studies of the mounds and objects found in them, but the larger part of the section, and of the work itself, 84 pages, is devoted to the archeological remains themselves. J. R. SWANTON.

ZOOGEOGRAPHY. *Life zone investigations in Wyoming.* MERRITT CARY. N. Amer. Fauna 42: 1-95, pls. 15, figs. 17. 1918.

This bulletin embodies the results of many years' exploration in Wyoming by the author and other members of the Biological Survey. These investigations serve to emphasize the diversified character of the physiography of Wyoming. Its chief characteristics are its many mountain ranges, vast, open rolling plains, and deep-cut valleys due to the numerous streams. The climate of the State is mainly arid, the rainfall from 10 to 20 inches, with warm summers and cold winters. As a consequence of these physiographic conditions the life zones of the State show remarkable diversity. Of the seven trans-

continental life areas all but two occur in Wyoming; and their interrelationships are, as would be expected, greatly complicated. These five zones with a few of their characteristic species are as follows:

The Upper Austral Zone (represented here by its western arid subdivision, the Upper Sonoran), which occupies most of the valleys and lower plains, is the home of the broad-leaved cottonwood, juniper, salt bush and yucca; of such mammals as *Eutamias minimus pictus*, *Citellus tridecemlineatus parvus*, *Lepus californicus melanotis*, and of such breeding birds as *Zenaidura macroura marginella*, *Tyrannus vociferans*, *Passerina amoena*, and *Icteria virens longicauda*.

The Transition Zone, which embraces the high plains, the basal slopes of the mountains, and all the foot-hills except the highest, and covers fully half the State, is characterized by yellow pine, narrow-leaved cottonwood, and sage brush; such mammals as *Odocoileus virginianus macrourus*, *Sciurus hudsonicus dakotensis*, *Neotoma cinerea cinerea*, and *Lepus townsendi campanius;* and such breeding birds as *Centrocercus urophasianus*, *Cryptoglaux acadica acadica*, *Empidonax wrightii*, *Cyanocephalus cyanocephalus*, and *Hylocichla fuscescens salicicola*.

The Canadian Zone, which covers the middle mountain slopes and the highest foot-hill ranges, is the boreal forest belt of spruce, fir, lodgepole pine, and aspen; and is furthermore delimited by such mammals as *Alces americanus shirasi*, *Glaucomys sabrinus bangsi*, *Phenacomys orophilus*, *Evotomys gapperi galei*, and *Lepus americanus americanus;* and such birds as *Charitonetta arbeola*, *Nuttallornis borealis*, *Melospiza lincolnii lincolnii*, and *Sitta canadensis*.

The Hudsonian Zone, which is a narrow belt covering the timber line region, is marked chiefly by the white-barked pine, dwarfed spruce and fir; together with such mammals as *Ovis canadensis canadensis*, *Eutamias oreocetes*, and *Ochotona uinta;* and such birds as *Nucifraga columbiana* and *Pinicola enucleator montana*.

The Arctic-Alpine Zone, which occupies the mountain crests and the portion of the peaks above timberline, is a treeless area, the vegetation of which is limited to low bushes and other humble plants like *Dryas octopetala* and *Poa arctica*, and is the home of such breeding birds as *Lagopus leucurus altipetens*, *Leucosticte australis*, *Leucosticte atrata*, and *Anthus spinoletta rubescens*.

Under each of these zones detailed lists of mammals, breeding birds, and plants are given, and a further list showing the distribution of all the conspicuous trees and shrubs of Wyoming which are of importance in delineating the life zones is also added.

HARRY C. OBERHOLSER.

SCIENTIFIC NOTES AND NEWS

MATTERS OF SCIENTIFIC INTEREST IN CONGRESS[1]

Mr. FESS has re-introduced his bill for a national university, which failed of final action in the Sixty-fifth Congress.[2] The present bill is H. R. 9353: "To create a national university at the seat of the Federal Government." The institution, to be known as the "National University of the United States," is to be governed by a board of trustees, consisting of the U. S. Commissioner of Education and twelve appointed members; the acts of the board are subject to approval by an advisory council, consisting of one representative (usually the president of the State University) from each State. No student is to be admitted unless he shall have obtained the degree of master of science or master of arts from an institution of recognized standing. No academic degrees are to be conferred. An initial appropriation of $500,000 is provided. The bill was referred to the Committee on Education.

A fact of interest to the scientific public is that the "Army reorganization bill" (S. 2715, Mr. WADSWORTH; and H. R. 8287, Mr. KAHN) makes no mention of the Chemical Warfare Service. In his letter accompanying the bill, Secretary of War BAKER suggests that the Chemical Warfare Service be made a part of the Engineer Corps. The proposal to abolish the Service as a distinct unit, comparable with the Tank Corps, is being vigorously opposed by the Council of the American Chemical Society.

Warnings issued by the Public Health Service in September that a recurrence of the 1918 pandemic of influenza was probable in the autumn months of 1919, stirred renewed interest in the various bills and resolutions providing for investigations of that disease, but no final action had been taken at the time of this report, although Mr. HARDING's S. J. Res. '76 was reported in the Senate on October 1.

On September 3, Mr. MCKELLAR introduced S. 2920: "To enable the Secretary of Agriculture to carry out investigations of the causes and means of prevention of fires and dust explosions in industrial plants." The bill provides $100,000 for such investigations. Referred to the Committee on Agriculture and Forestry.

A plan for private development, under Federal concessions, of the platinum resources of Alaska is contained in H. R. 8988: "To incorporate the United States Platinum Corporation and to aid in the development of the mineral resources of Alaska, and for other purposes," introduced on September 3 by Mr. O'CONNELL (by request). The proposed Corporation would have a capital stock not to exceed $50,000,000; would be exempt from Federal taxation; would be empowered to receive concessions and leases of government-owned platinum sands in Alaska; would pay a royalty of one-eighth of its net products; and would furnish $100,000 for the maintenance of five "U. S. Government Commissioners of Platinum and its Allied Industries," whose duties are not defined in the bill. Referred to the Committee on Public Lands.

[1] Preceding report: This JOURNAL 9: 454. 1919.

[2] See This JOURNAL 8: 76. 1918.

No action was taken on the invitation of the French Government[8] to send delegates to a meteorological conference in Paris on September 30, and the United States was, therefore, not officially represented.

NOTES

The proposed American Meteorological Society, formal organization of which is suggested for action in connection with the next meeting of the American Association for the Advancement of Science, is expected to have a large Washington membership, drawn from the staff of the Weather Bureau and from among the meteorologists of the Army and Navy. It is suggested that the *Monthly Weather Review* be made the medium for publishing meteorological and climatological articles, while a monthly leaflet published by the Society would contain news, announcements, notes, and queries.

Mr. L. B. ALDRICH of the Astrophysical Observatory reports from the Smithsonian Station on Mt. Wilson, California, the successful operation of a new instrument for measuring the loss of heat of the earth to space at night.

Prof. ALFRED F. BARKER, Professor of Textile Industries at the University of Leeds, England, visited Washington in September to study the work being done in the Division of Textiles of the National Museum.

Dr. C. BONNE and his wife, Mrs. C. BONNE-WEPSTER, of Surinam (Dutch Guiana), students of South American mosquitoes, are spending two months at the National Museum in the study of the mosquito collection.

Mr. R. Y. FERNER, formerly with the Bureau of Standards, has resigned his position as assistant purchasing officer in the Emergency Fleet Corporation, where he had charge of the purchase of navigational outfits, and has opened an office in the Maryland Building, Washington, for the supplying of technical information and service to manufacturers and others.

Brig. Gen. CHARLES F. LEE, of the British Royal Air Force, who lectured before the Academy in March, 1918, on "Aviation and the War," was killed in an aeroplane accident in England on September 2.

Mr. PAUL C. STANDLEY, of the Division of Plants, U. S. National Museum, has returned from a collecting trip through Glacier National Park, Montana. Data were secured for a handbook of the plants of the Park, to be issued by the National Park Service for the use of tourists. About four thousand herbarium specimens were collected.

[8] This JOURNAL 9: 455. 1919.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 9 NOVEMBER 4, 1919 No. 18

PHYSICS.—*The spectral photoelectric sensitivity of molybdenite as a function of the applied voltage.* W. W. COBLENTZ and H. KAHLER, Bureau of Standards.

In a previous investigation it was observed that the spectral photoelectric sensitivity of molybdenite is confined practically within three spectral bands, the maxima of which are separated by equal intervals, when plotted in terms of frequency instead of wave lengths.

The present investigation was undertaken in order to test the validity of this frequency relation, using for the purpose a quartz prism which gave twice the dispersion formerly obtained with a fluorite prism. The sample of molybdenite was soldered to copper wire terminals, and operated in an evacuated chamber as in previous work. The photoelectric substance, the dry battery and the d'Arsonval galvanometer were connected in series. The deflection caused by the small dark current was overcome by rotating the suspension head of the galvanometer.

The results obtained with this apparatus appear to verify the previous observations, indicating that the frequency maxima of photoelectrical sensitivity are separated by equal intervals, which decrease with temperature; the arbitrary wave-number being $n = 40$ at 25°C. and $n = 30$ at −175°C.

A new voltage phenomenon.—A photo-negative action (resistance increase) has been observed in certain samples of selenium,[1] when exposed to the total radiation from an incandescent

[1] RIES, Phys. Zeits. 9: 569. 1908. BROWN, Phys. Rev. 33: 1. 1911.

lamp. A similar spectral photo-negative response was observed in some samples of stibnite,[2] when exposed to radiations of wave-lengths less than $\lambda = 0.657\ \mu$ But heretofore no one appears to have observed that, for wave-lengths less than about $0.65\ \mu$, the nature of the photoelectric response depends upon the voltage applied to the substance under test.

We have found in some samples of molybdenite that, for the visible spectrum extending to about $\lambda = 0.647\ \mu$, the electric response is photo-positive or photo-negative, depending upon the voltage applied to the terminals of the receiver. For wave-lengths greater than $\lambda = 0.647\ \mu$ the photoelectric response was observed to be photo-positive whatever the applied voltage.

The region of transition in the spectrum, in which the action changes from photo-negative to photo-positive, is very narrow—less than 9 AU.

The critical voltage is very small, as may be inferred from the fact that an increase of 1.3 volts (additional dry cell) changed a positive-negative galvanometer deflection of $\pm$ 1 cm. into a purely negative deflection of —24 to —26 cm, which is the photo-negative response under discussion

There seem to be two contending forces acting. The one which causes the photo-positive response acts quickly and prevails on low voltage. The photo-negative action builds up more slowly and is predominant on high voltages. As a result of these two forces, for certain applied voltages, on exposing the molybdenite receiver to light of wave-lengths less than $0.647\ \mu$, the galvanometer deflection is first positive, then decreases in value (and may even become negative) when, on shutting off the light stimulus, there is a further deflection in the negative direction, after which the deflection returns to the original zero scale reading.

For example, using the wave-length $\lambda = 0.5876\ \mu$ as a light stimulus, and applying a potential of 10 volts, the galvanometer deflection was almost entirely positive. On 20 volts the deflection was partly positive and partly negative. On 29 volts the positive response was almost eliminated, and the negative

[2] ELLIOT, Phys. Rev 5: 62. 1915.

response prevailed. On 33 volts the galvanometer deflection was entirely negative and eight times as large as the observed maximum purely positive deflection for 10 volts. In another test, at a slightly lower temperature (—104°C.), which raises the critical voltage, changing from 35.6 volts to 37 volts transformed the positive-negative deflection of ± 5 mm. into a negative deflection of —230 mm.

These tests were carried out at —100°C. to —178°C. It is of interest to note that the photo-positive action is the same as a resistance decrease caused by a rise in temperature of the material, while the photo-negative action is similar to the building up of a counter-electromotive force (the electrolytic action), previously observed in silver sulfide. An equal-energy spectrum was used for the radiation stimulus and if this phenomenon were the result of heating and of electrolytic action, then the photo-positive response should occur in the short wave-lengths where the absorption is greatest, and the photo-negative response should occur in the long wave-lengths where the photoelectric activity is the greatest. This is just the reverse of what has been observed.

No explanation of this phenomenon is attempted at this time. Even if it is "only a gas effect," "electrolytic action" or "surface charge," it is unique in being selective as to the wave-length of the exciting radiation and in being photo-positive or photo-negative, depending upon the applied voltage. It therefore requires further investigation.

GEOCHEMISTRY. *The oxidation of lava by steam.* J. B. FERGUSON, Geophysical Laboratory, Carnegie Institution of Washington.

Crystals of olivine and other iron-bearing minerals are found associated with glass in the normal Kilauean lava, and some years ago the question arose as to whether their presence might be taken as evidence bearing upon the probable water content of the volcanic exhalations. Preliminary experiments[1] made

[1] DAY, A. L., and SHEPHERD, E. S., *Water and volcanic activity.* Bull Geol. Soc. Amer. 24: 602. 1913. Smithsonian Report for 1913, 302 (Publication 2286).

at that time by the writer indicated that the lava was not appreciably attacked by water vapor at temperatures in the neighborhood of 1000°C. and that the presence in the lava of so much iron in the ferrous condition was not at variance with the water content of the emanations observed by Day and Shepherd.[2] These experimental results, obtained in 1912 and 1913, are now presented as a matter of record.

Most of the writers who have speculated upon the rôle that water plays in the chemical reactions which take place in the volcanic vent during an eruption have based much of their speculation upon the equation[3]

$$3FeO + H_2O \rightleftarrows Fe_3O_4 + H_2 + 15400 \text{ cal.}$$

This equation must not be taken too literally, because recent investigations[4] have indicated that the action of steam upon a ferrous iron oxide at high temperatures gives rise to a "magnetite" of variable composition. The actual composition obtained is dependent upon the temperature.[5]

An analysis of a fresh flow of Kilauean lava[6] shows 9.28 per cent FeO and 1.92 per cent Fe_2O_3. The ratio of ferrous to ferric iron in this rock is much greater than the ratio in magnetite (1 : 2) and, were we dealing with the pure iron oxides only, this fact might be used as an argument against the presence of a preponderance of water vapor in the gas phase. The lava, however, does not contain ferrous oxide as a separate phase. The ferrous iron exists mainly in the silicate minerals and the glass, together with a little in the traces of magnetite which are probably present, although microscopic examination does not show appreciable amounts of Fe_3O_4. The equations which would

[2] DAY and SHEPHERD, Loc. cit. SHEPHERD, E. S., Bull. Hawaiian Volcano Obs. 7 (July). 1919.

[3] CHAMBERLIN, R. T., Carnegie Publication No. 106: 66. 1903. R. A. DALY, *Igneous rocks and their origin*, p. 272. 1914. VON WOLFF, *Vulkanismus*, I, p. 116. 1914.

[4] HILPERT, S., and BEYER, J., Ber. deutsch. Chem. Ges. 44: 1618. 1911.

[5] The whole problem of the various oxides of iron is an exceedingly difficult one to study experimentally and much yet remains to be done before the problem can be considered satisfactorily solved.

[6] FERGUSON, J. B., Am. Journ. Sci. 37: 400. Analysis B. 1914.

represent the reaction between water and the ferrous iron in the silicates might be quite different in character from the equation given for the pure oxides, and an assumption of analogous behavior in these cases appears to be a somewhat risky matter.[7] Indeed, Thaddéef's[8] results upon the oxidation of olivine by ignition in air indicate that the oxides are much more easily oxidized than is the ferrous iron of the olivine. He found that only two-thirds of the iron present in this silicate could be oxidized by such ignition, whereas it is common knowledge that ferrous oxide would be readily changed to ferric oxide under similar treatment.[9]

My results qualitatively confirm the observations of Thaddéef in this respect and were carried out as follows:

Materials.—A piece of lava from the crater floor of Kilauea was crushed in a hardened steel mortar and the part that passed the twenty but not the forty mesh sieve (0.38–0.86 mm.) and also the part that passed the two hundred mesh sieve (less than 0.074 mm.) were used.

The nitrogen was made from sodium nitrite, or by removal of oxygen from air by copper, and was passed through the usual purifying and drying train.

Apparatus and procedure.—The furnace was a platinum-wound resistance furnace of the type usually employed in this laboratory. The temperatures were determined by means of a platinum-platinrhodium thermoelement and a suitable potentiometer set-up. A long porcelain tube was placed in the furnace so that it projected twenty or thirty cm. out of the furnace at one end and five or six cm. at the other. The charge was placed in a platinum boat in the porcelain tube, and the boat had attached to it a stiff platinum wire which enabled one to insert the boat into the hot portion of the tube or to withdraw it into the colder portion at will.

[7] Such an assumption appears to have been made by Brun, who states that water vapor directly oxidizes the ferrous silicate to magnetite. His statement is not confirmed by analyses of the solid products after reaction with water, but rests on the change in color of the rock and the presence of hydrogen, together with CO and CO_2, in the gases evolved. Arch. sci. phys. nat. 41: 404. 1916.

[8] Thaddéef, K. Z., Kryst. 26: 77. 1896.

[9] Sosman, R. B., and Hostetter, J. C., Journ. Amer. Chem. Soc. 38: 820. 1916.

For the steam experiments the steam-generating apparatus was attached to that end of the porcelain tube which projected 5–6 cm. from the furnace. This apparatus consisted of a boiler and pre-heater. The latter also acted as a trap for liquid water. The boiler had two valves so that the water in it could be boiled for some time to expel all oxygen before an experiment was started. The rest of the apparatus was so arranged that it could be initially swept out with pure nitrogen and then, after the steam had been shut off at the close of an experiment, could be again filled with nitrogen. The water that condensed in the cold portion of the porcelain tube was wiped out before the boat was withdrawn. During the wiping-out process and the cooling of the charge an atmosphere of pure nitrogen was maintained.

Typical experiment.—Five grams of lava powder were placed in the platinum boat and the boat placed in the cold end of the porcelain tube. Nitrogen was then admitted to the apparatus and all the air swept out. The boat was then pushed into the hot portion of the porcelain tube. The nitrogen was partly shut off and steam admitted. When a good flow of steam was obtained through the furnace the nitrogen was entirely shut off. The porcelain tube was so tilted that the water condensing in the colder portion of the tube, after passing the hot zone, would drain away from the furnace. After the experiment had run for the desired time the steam was gradually replaced by nitrogen. The liquid water in the end of the porcelain tube was wiped out (a good flow of nitrogen prevented the access of air during this operation) and then the boat was withdrawn to the cold portion of the tube and, when cold, removed. A part of the charge was analyzed for ferrous iron by the modified Pratt method as used by Washington.[10] Calcium phosphate as recommended by Gage was used to aid in the determination of the end points in the permanganate titration.[11] It should be noted that if any of the reducing gases present in the rock dissolved when the rock sample was brought into solution, they would be titrated and would appear as ferrous iron.

[10] WASHINGTON, H. S., *The chemical analysis of rocks*, 2d Ed., p. 136–138. 1910; 3d Ed., p. 186–190. 1919.

[11] Journ. Amer. Chem. Soc. 31: 381–385. 1909.

TABLE 1

RESULTS OF EXPERIMENTS WITH A KILAUEAN LAVA IN CONTACT WITH NITROGEN AND STEAM

Exp No	Initial FeO content	Final FeO content	Gas employed	Time of exposure Hours	Fineness of powder. Meshes per inch	Temp. ° C.	Percentage decrease in FeO	Remarks
1	8.69 8.69 8.71	7.93	nitrogen	1	20–40	1000	8.8	
2	8.69 8.69 8.71	7.90	nitrogen	1	20–40	1000	9.2	
3	8.69 8.69 8.71	8.25	nitrogen	1	20–40	1000	5.2	
4	8.69 8.69 8.71	8.16	nitrogen and steam	2 (steam)	20–40	1000	6.2	
5	8.69 8.69 8.71	7.91	nitrogen and steam	2 (steam)	20–40	1000	9.1	
6	8.69 8.69 8.71	7.98	nitrogen and steam	2 (steam)	20–40	1000	8.3	
7	8.69 8.69 8.71	7.91	nitrogen and steam	2 (steam)	20–40	1000	9.1	
8	8.69 8.69 8.71	8.31	nitrogen and steam	1 (steam)	20–40	1100	4.5	
9	8.69 8.69 8.71	8.37	nitrogen	1	20–40	1100	3.8	
10	9.32	7.84 7.80	nitrogen	1 1/2	200	1000	16.1	Air pumped out of charge and replaced by nitrogen before charge inserted into hot part of tube
11	9.32	8.18	nitrogen	1/4	200	1000	12.2	
12	9.32	8.06	nitrogen	1	200	1000	13.5	
13	9.32	7.80	nitrogen	1	200	1000	16.3	
14	9.32	7.87	nitrogen	1/2	200	1000	15.6	
15	9.32	7.93[1] 7.92[2]	nitrogen	1	200	1000	14.9 15.0	
16	9.32	7.95 8.37	nitrogen and steam	1 (steam)	200	1000	12.5	
17	9.32	8.26	nitrogen 0.1 mm. pressure	1/2	200	1000	11.4	Time for experiments 2 hrs., including heating and cooling
18	9.32	7.95	nitrogen 0.1 mm. pressure	1/2	200	1000	14.7	

[1] Top of charge. [2] Bottom of charge.

The results obtained in the experiments at atmospheric pressure and at a low pressure of nitrogen are given in table 1.

In addition, the results of two miscellaneous experiments are given below.

(19) Some of the lava powder was heated in a platinum crucible in air over a Meker burner for two hours. The ferrous iron content was then found to be 1.94 per cent.

(20) Some of the oxidized product obtained in experiment (19) was heated in a partial vacuum (0.1 mm. of nitrogen) for 4 hours at 1100°C. The ferrous iron value was then found to have been raised from 1.94 to 3.90 per cent. A duplicate analysis gave 3.87 per cent.

Discussion.—The results given in table 1 show that after heating there is a decrease in the ferrous iron content of the rock amounting, in terms of the ferrous iron originally present, to 4–9 per cent for the coarse powder and 11–16 per cent for the fine powder. The variations within each group are not traceable in any way to the gas phase present. In fact the steam appears to have acted like an inert gas.[12]

Just what is the complete cause of the decrease noted is somewhat of a question. A certain apparent decrease in the ferrous iron content might be expected from the loss of the reducing gases which are liberated upon heating the lava, and some decrease might also arise from the taking up of some iron by the platinum boat.[13] An actual decrease would occur if part of the ferrous iron were oxidized by adsorbed gases. These effects, would, however, be expected to be small.

The decrease in ferrous iron must therefore be ascribed mainly to some reaction within the lava sample itself. The magnetite which formed when the lava crystallized[14] was probably the last

[12] It cannot be argued that the gas reacted only with the surface material and did not penetrate the charge, for experiment (15) shows that samples from the bottom and top of the charge contain exactly the same amount of ferrous iron. Also it can hardly be argued that there was a surface attack upon the lava grains since the results with both fine and coarse materials show the same independence of the gas phase, and the same final ferrous iron content.

[13] SOSMAN, R. B., and HOSTETTER, J. C., This JOURNAL. 5: 293. 1915.

[14] After an experiment the material was found completely crystallized, although originally containing much glass.

material to dissolve during the decomposition of the sample with hydrofluoric and sulphuric acids, and if the formation of this mineral were at the expense of the oxygen in the remainder of the lava, the analytical results would probably not indicate this but would rather show merely less ferrous iron. The mechanism of such a reaction within the lava with the formation of magnetite can only be speculated upon. Sosman[15] has suggested the possibility of the presence of iron (Fe) in solution in the glass or minerals after this reaction. Another possible reaction would be the formation of a lower oxide of titanium than the TiO_2 usually reported.

The fact that both the fine and coarse material, although of slightly different initial ferrous iron content, contain practically the same percentages after treatment is probably traceable to the larger percentage of glass and smaller percentage of Fe_3O_4 in the fine material.

Whatever the cause of the small decrease in ferrous iron, and of the variations therein, the experiments leave no doubt that considerable ferrous iron, when in silicate combinations, can exist in the presence of water vapor at high temperatures.

The vacuum experiment (No. 20) with the oxidized material shows clearly the ease with which oxygen can be removed from such materials and indicates that due regard must be given to this phenomenon not only in the study of the chemistry of lavas, but also in the interpretation of the results obtained in experiments in which gases are pumped from rocks at high temperatures.

The data given in this article are of a qualitative rather than a quantitative character, and are not to be regarded as final data on the reactions of water vapor with iron-bearing silicates. The complete story cannot be obtained by experiments on so complex a material as a natural lava, but must be learned by experiments with simple silicates of known composition. These results are presented here, however, on account of their current interest and in the absence of any fundamental data on the reactions concerned.

[15] Private communication; see also this JOURNAL 7: 58. 1917

The microscopic examination of the samples was made by H. E. Merwin of this Laboratory.

RECAPITULATION

Under certain conditions steam is capable of oxidizing iron and its lower oxides to magnetite, Fe_3O_4, or to ferric oxide, Fe_2O_3. This fact has often been quoted as an indication of the probable oxidizing action of steam upon lava during volcanic activity. In this paper this reasoning from analogy is subjected to the light of recent investigations and found wanting. In addition, some experimental results are given which confirm the view that the ferrous iron is not thus oxidized, and indicate that the presence of much ferrous iron in the lava and much steam in the volcanic emanations of Kilauea are two facts which are in full accord. Several miscellaneous experiments are also reported which show that in the experimental study of the chemistry of the lavas careful attention must be paid to the character of the gas phase in contact with the lava if results of value are to be obtained. The bearing of these experiments upon the interpretation of the results obtained by pumping gases from rocks at high temperatures need only be mentioned.

BOTANY.—*History of the Mexican grass,* Ixophorus unisetus. A. S. HITCHCOCK, Bureau of Plant Industry.

In 1791 Thaddeus Haenke, a Bohemian botanist accompanying Malaspina on an exploring expedition to the Pacific coast of America, visited Mexico, stopping at San Blas and Acapulco. From the latter place he visited the interior of the country. His collections were sent to Prague and were examined by the botanists J. S. Presl and C. B. Presl, who finally published an account of a few families, including the grasses,[1] under the title, *Reliquiae Haenkeanae.* In this work 15 genera and about 250 species of grasses were described as new. They came from the western coast of South America, Panama, Mexico, Monterey (California), Nootka Sound (Vancouver Island), and the Philippine and Marianne Islands. Some of the species, supposed to be new, proved to be the same as others previously described,

[1] PRESL, Rel. Haenk. 1: 207–349, pl. 37–48. 1830.

but a large number are still maintained as valid. The plants were deposited at the Bohemian Museum but, when the German University was established, the collections were divided, a part going to each institution. In 1907 the writer found a part of the Haenke grasses at the Bohemian Museum and a part at the German University. The labels on the specimens are meager, usually merely a single word, such as Mexico, Panama, Acapulco, and sometimes even this lacking. There is not always an agreement between the label on the specimen and the locality as published by Presl, and in a few cases there is evidence that the labels have been misplaced.

The grass under consideration was described as *Urochloa uniseta*. The genus Urochloa was based upon *Urochloa panicoides*,[2] a species of Panicum from Île de France (Mauritius), referred to later in this article. This species has the spikelets in one-sided spikelike racemes with one or two slender stiff hairs on the pedicel below the spikelets. In Presl's species the spikelets are in similar one-sided spikes and are subtended by bristles, a single one below each spikelet, these bristles being, however, sterile branchlets instead of hairs or trichomes as in *Urochloa panicoides*. The locality of *U. uniseta* as published is merely Mexico. The type specimen, at the German University, is labeled, "Urochloa uniseta Pr. Mexico, H." It is the upper part of a culm bearing three leaves and a panicle of about 20 spikes.

In 1834 Trinius, in revising the section Setaria of the genus Panicum, remarked that Presl's *Urochloa uniseta*, which apparently he had not seen, probably belonged in Setaria and named it *Panicum unisetum*.

In 1862 Schlechtendahl revised Setaria and its allies and established the genus Ixophorus, basing it upon *Urochloa uniseta* Presl. He also mentioned a specimen collected by Schiede, which he called *I. schiedeana*. This species is not described, the author merely saying that it is more delicate and the bristles are thinner and longer.

In 1886 Fournier, who wrote an account of the grasses of Mexico, described a new species of Setaria which he called *S. cirrhosa*,

[2] Beauv. Ess. Agrost. 52. pl 11. fig. 1. 1812.

based upon a specimen (No. 387) collected at San Agustin (Oaxaca) by Liebmann, a Danish botanist, who made extensive collections in Mexico (Vera Cruz and Oaxaca). The type specimen of this species was kindly sent for examination by the Director of the Botanical Museum at Copenhagen. It proves to be the same as *Ixophorus unisetus*. The specimen bears, in Fournier's handwriting, the name *Panicum cirrhosum* Fourn. n. sp., a name which, in publication, he changed to *Setaria cirrhosa*.

The species just mentioned is the fifth species of Setaria in Fournier's account. His sixth is *Setaria uniseta*, based upon *Urochloa uniseta* Presl. As number seven he lists without description *Setaria schiedeana*, based on *Ixophorus schiedeanus* Schlecht., stating that he has not seen this and that Schlechtendahl does not describe it, thus inflicting on the botanist another nomen nudum.

Thus the species remained until 1893, when several manuscript descriptions of Dr. George Vasey were published after his death. Under the name *Panicum* (*Ptychophyllum*) *palmeri* Vasey is published a new species based on a specimen collected by Dr. E. Palmer at Tequila, Jalisco, in 1886. Vasey remarked that this is near *Setaria cirrhosa* Fourn. Vasey referred this to the section Ptychophyllum of Panicum because of the single bristle below the spikelets, because of the inflorescence, which resembles that of *P. sulcatum*, and perhaps because of the rather broad blades.

In 1895 Dr. J. N. Rose published an account of the plants collected in Mexico by Dr. E. Palmer in 1890 and 1891. Among the grasses is a new species credited to Dr. Vasey, *Panicum* (*Ptychophyllum*) *pringlei*. The specimens mentioned are *Pringle* 2047 and 2423, and *Palmer* 1256 in 1891. All are small forms of *Ixophorus unisetus*. Because of the specific name and because Dr. Vasey has written the name upon *Pringle* 2423, this specimen is the type.

In 1896 Beal published the same species as new under the name *Panicum schiedeanum* "Trin. ex. Steud. Nom. Ed. 2, 2: 263 (1841). P. Pringlei Vasey in ed.," basing it on Pringle's No. 2423 from Jalisco, which is the type of *Panicum pringlei*. Beal

uses the name *P. schiedeanum* because it appears on the printed labels of the plants distributed by Pringle (No. 2423) The citation given by Beal, however, is a nomen nudum (a name without description or citation of a synonym). A specimen in the Trinius Herbarium labeled *Panicum schiedeanum* is a species of Paspalum. Beal gives *Panicum palmeri* Vasey on a succeeding page as a distinct species.

In 1897 Scribner revised the genus Ixophorus, describing *I. unisetus*, *I. pringlei* Scribn. "(*Panicum schiedeanum* Beal, not Trin.)," and *I. pringlei* var. *minor* Scribn.

The descriptions of the forms do not differ except in the size of the vegetative parts, the specimens assigned to *I. pringlei* being smaller, the blades shorter and narrower, and the spikes fewer and shorter. The variety is a still more depauperate form, with blades only 1 to 3 inches long (*Palmer* 1256 in 1891 from Colima, Mexico).

Finally, in 1900, Scribner and Merrill, in their revision of the genus Chaetochloa (Setaria), listed among the excluded species *Setaria cirrhosa* Fourn. (see above), which they refer to *Panicum* as *P. cirrhosum*. In this they depended upon Fournier's description as they had not seen the single collection cited by him.

The above account of the nomenclatorial history of a little-known species is instructive as showing how variable are the judgments of different botanists, or of the same botanist at different times, when working with inadequate material. The single species has been described under five different specific names and has been referred to four genera. Fournier had not seen Presl's specimen and American authors had not seen Fournier's nor Presl's specimens. Only recently has there been sufficient material to confirm the judgment that all the forms belong to one species.

A peculiarity of the sterile palea is worthy of note. At first the margins, wide and thin, overlap and inclose the three large anthers of the sterile or lower floret. At maturity the margins expand and spread around the sterile lemma, appearing winglike and papery. This expansion appears to be rather sudden as it is observed only in specimens with fruiting spikelets.

Ixophorus unisetus is cultivated in Costa Rica as a forage grass under the name of Honduras grass (Zacate de Honduras).

The synonymy of the species and a list of the specimens in the National Herbarium follow:

IXOPHORUS UNISETUS (Presl) Schlecht.

Urochloa uniseta Presl, Rel. Haenk. 1: 319. 1830.

Panicum unisetum, Trin. Mem. Acad. St. Pétersb. VI. Sci. Nat. 1: 217. 1834.

Ixophorus unisetus Schlecht., Linnaea 31: 421. 1862.

Ixophorus schiedeanus Schlecht. Linnaea 31: 421. 1862.

Setaria schiedeana Fourn., Hemsl. Biol. Centr. Amer. Bot. 3: 505. 1885.

Setaria uniseta Fourn., Hemsl. Biol. Centr. Amer. Bot. 3: 506. 1885

Setaria cirrhosa Fourn., Mex. Pl. 2: 43. 1886.

Panicum palmeri Vasey, Contr. U. S. Nat. Herb. 1: 281. 1893.

Panicum pringlei Vasey, Contr. U. S. Nat. Herb. 1: 363. 1895.

Panicum schiedeanum Trin., Beal, Grasses N. Amer. 2: 119. 1886.

Ixophorus pringlei Scribn., U. S. Dept. Agr. Div. Agrost. Bull. 4: 6. pl. 2. 1897.

Ixophorus pringlei minor Scribn. U. S. Dept. Agr. Div. Agrost. Bull. 4: 7. 1897.

Panicum cirrhosum Scribn. & Merr., U. S. Dept. Agr. Div. Agrost. Bull. 21: 40. 1900.

DISTRIBUTION

SAN LUIS POTOSÍ: Rascon, *Purpus* 5425.

TEPIC: Acaponeta, *Rose* 14253.

JALISCO: Tequila, *Palmer* 372 in 1886. Valley of the Río Grande de Santiago, *Pringle* 2423. Near Guadalajara, *Pringle* 2047.

MORELOS: Trimenta, *Orcutt* 4407. Valley of Cuautla, *Pringle* 8493. Cuernavaca, *Hitchcock* 6821, 6841.

COLIMA: Colima, *Palmer* 141 in 1897, 1256 in 1891. Alzada, *Hitchcock* 7070, 7091. Jala, *Hitchcock* 7007.

GUERRERO: Iguala, *Hitchcock* 6695. Balsas, *Hitchcock* 6805.

GUATEMALA: Patulul, *Heyde & Lux* 6401.

SALVADOR: San Salvador, *Renson* 301, 362. Sonsonate, *Hitchcock* 8977.

NICARAGUA: Corinto, *Hitchcock* 8614. Realejo, *Hitchcock* 8750.

COSTA RICA: Guadelupe, *Tonduz* 14480 (cultivated).

In a preceding paragraph it was stated that the genus Urochloa, to which *Ixophorus unisetus* was first referred, was based upon a single species, *U. panicoides* Beauv. (1812). A few years later (1816) Poiret described the same species as *Panicum javanicum*. In 1821 Trinius, in an article entitled *Agrostographische Beyträge*,[1] published an allied species from the East Indies, as *Panicum helopus*. Later authors confused the two species and Hooker in his *Flora of British India* unites them under the name *P. javanicum*. This author, who is much given to placing under one name several allied species, makes the following statement under *P. javanicum*: "Kunth (Revis. Gram. 1. 206) says, under *Urochloa panicoides*, that he has examined in Desfontaine's Herbarium the type of Poiret's *P. javanicum*, and identified it, which he cites as a syn. of *Urochloa panicoides*, but his figure of which again quite accords with a narrow-leaved form of *P. helopus*, Trin. This requires the adoption of the name *javanicum* (by misprint *japonicum* in Kunth Revis.) for the species. Bentham, on the other hand (*Fl. Austral.*, vii 477), says that Munro has seen an authentic specimen of *javanicum*, and that it is quite distinct from *P. helopus*. I have no means of verifying either authority." The original description of *P. javanicum* states that the spikelets are glabrous; the original description of *P. helopus* states that the spikelets are hirsute. Beauvois's figure, accompanying the original description of *Urochloa panicoides*, shows the spikelets to be glabrous. Thus one can easily distinguish the two species without consulting the evidence of which Hooker speaks.

The species with glabrous spikelets should be known as **Panicum panicoides** (Beauv.) Hitchc. (*Urochloa panicoides* Beauv. Ess. Agrost. 52. pl. 11. fig. 1. 1812; *Panicum javanicum* Poir. in Lam. Encycl. Suppl. 4: 274. 1816).

[1] Spreng. Neu. Entd. 2: 84. 1821.

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

GEODESY.—*General theory of polyconic projections.* OSCAR S. ADAMS. U. S. Coast and Geodetic Survey, Spec. Publ. 57. Pp. 174. pl. 1. figs. 48. 1919.

In this publication an attempt has been made to give a fairly complete treatment of the various systems of projection in which the parallels are represented by a group of non-concentric circles with the centers of these circles all lying upon a straight line. The number of such systems is unlimited; the aim has been, therefore, to give a development of the projections that are most frequently met with in practice. Some attention, however, is given to more general theoretical considerations in order to illustrate the way in which particular properties can be attained in a given projection by the introduction of analytical conditions in the mathematical definition of the projection.

In the treatment of any particular projection, the development is given first from the standpoint of the simpler geometrical or analytical principles upon which it is based, and later the same results are deduced from the more general principles that may be found to apply to the projection under consideration. This method of attack is found more rigidly applied in the case of the conformal polyconic projections than in the treatment of any other class in the polyconic group. The comparatively simple geometrical or analytical development is first given and this is followed by a development of the results by the employment of functions of a complex variable in accordance with the principles demonstrated by Gauss and Lagrange.

A full mathematical treatment of the ordinary or the American polyconic projection is given in the latter part of the volume. No adequate development of this has ever before been given in one volume in an American publication. Information in regard to it has been largely confined to articles in the various annual reports of the Superintendent of the U. S. Coast and Geodetic Survey, and the result has been that it was difficult to get copies of the articles on account of the exhaustion of the supply of the reports in which the articles were found.

This volume will, therefore, serve to meet the requirements of those who wish to have information with regard to the mathematical principles underlying this projection, which has always been extensively used in America. O. S. A.

PHYSICS.—*Some optical and photoelectrical properties of molybdenite.* W. W. COBLENTZ and H. KAHLER. Bur. Stand. Sci. Paper 338. Pp. 51. 1919.

This paper gives data on the transmissivity and the reflectivity of molybdenite; also data upon its change in electrical conductivity, when exposed to thermal radiations of wave-lengths extending from the ultra-violet into the extreme infra-red. The effect of temperature, humidity, intensity of the exciting light, etc., upon the photoelectrical sensitivity of molybdenite were investigated.

It was found that: (1) samples of molybdenite obtained from various localities differ greatly in sensitivity; (2) there are maxima of sensitivity in the region of 0.73 μ, 0.85 μ, 1.08 μ, and 1.8 μ; (3) there is no simple law governing the variation in the photoelectric response with variation in intensity of the radiation stimulus; (4) the increase in photoelectric current with increase in intensity of the incident radiation is greatest for infra-red rays. It is greatest for low intensities of the exciting light and it is greatest on the long wave-length side of the maximum; (5) the photoelectric sensitivity increases with decrease in temperature. At 70°C. the bands at 1.02 μ and 1.8 μ have practically disappeared. On the other hand, at liquid air temperatures, the greatest change in electrical conductivity is produced by radiations of wave-lengths between 0.8 μ and 0.9 μ.

Unlike selenium, molybdenite appears unique in being photoelectrically sensitive to infra-red rays, extending to about 3 μ. W. W. C.

BOTANY. *Flora of the District of Columbia and vicinity.* A. S. HITCHCOCK and PAUL C. STANDLEY, with the assistance of the botanists of Washington. Contr. U. S. Nat. Herb. 21. Pp. 329. pls. 42. fig. 1. 1919.

The area included by the Flora is approximately a circle of 15 miles radius, with the Capitol as the center. The formal list includes all indigenous plants and all introduced ones that have become established. All the species admitted to the list are based upon specimens in the District Flora Herbarium, which has been segregated from the main collection of the National Herbarium. Species reported but which are

not supported by specimens are mentioned in notes. All the species mentioned in Ward's Flora (the standard list of the region up to the present) and its Supplements have been accounted for, even though they cannot now be verified by specimens, some in synonymy and some as being errors of identification. There are formally listed 646 genera and 1630 species, and many more are mentioned in notes as being waifs. There are two keys to families, one based mainly upon vegetative characters, the other mainly upon floral characters. There are also keys to genera and to the species. Under each species is mentioned the common name, the habitat, the distribution in the District, the flowering period and the general distribution. An introduction gives a brief history of botanical activity in the District and a short account of the geologic and ecologic features of the region. The work concludes with a Glossary and Index and is accompanied by 42 plates giving 57 halftones, some illustrating the ecologic features of the flora, others several of the interesting species. A. S. H.

ORNITHOLOGY.—*Washington region.* (February and March, 1918.) HARRY C. OBERHOLSER. Bird Lore 20: 231–32. 1918.

February and March are usually the least favorable months for bird observations about Washington. In the year 1917, however, these months were notable for the many ducks which frequented the Potomac River. Two species, *Marila americana* and *Spatula clypeata*, both of which are rare about Washington, particularly in the spring, were observed in March. Furthermore, *Nettion carolinense* and *Aristonetta valisineria* remained later than ever before. Notwithstanding the very severe winter a number of early migrants appeared considerably ahead of their schedule; *Fulica americana* on March 9, earlier than any previous record. Some species, such as *Regulus satrapa*, *Nannus hiemalis hiemalis*, and *Sitta canadensis canadensis* have been unusually scarce; others, such as *Passerella iliaca*, at times more than commonly numerous. H. C. O.

ORNITHOLOGY.—*Notes on North American birds. VII.* HARRY C. OBERHOLSER. Auk 36: 81–85. January, 1919.

An investigation of the American *Nettion carolinense* shows that this bird is clearly a distinct species and not a subspecies of the European *Nettion crecca*. On the other hand, *Circus hudsonius* (Linnaeus) proves to intergrade individually with *Circus cyaneus* of Europe, and should, therefore, stand as *Circus cyaneus hudsonius* (Linnaeus). The gray

sea eagles from eastern Asia prove to be subspecifically different from the European *Haliaeetus albicilla* and should be called *Haliaeetus albicilla brooksi* Hume. The birds of this species occurring on the Aleutian Islands belong, of course, to this race, and *Haliaeetus albicilla brooksi* is thus added to the North American list. The American bird now called *Larus brachyrhynchus* proves to be only subspecifically different from *Larus canus* of Europe, and its name, therefore, should be *Larus canus brachyrhynchus*. Although *Corvus caurinus* Baird has been commonly considered a distinct species, there is apparently nothing in either size or color to warrant its status as other than a subspecies. It, therefore, should hereafter be called *Corvus brachyrhynchus caurinus* Baird. The golden warbler commonly known as *Dendroica bryanti castaneiceps* Ridgway proves now to be a subspecies of *Dendroica erithachorides* Baird, since *Dendroica bryanti* is found to intergrade with the latter. Its name, therefore, should be *Dendroica erithachorides castaneiceps* Ridgway. H. C. O.

ORNITHOLOGY.—*Mutanda ornithologica. V.* HARRY C. OBERHOLSER. Proc. Biol. Soc. Wash. 32: 7–8. Feb. 14, 1919.

The woodpecker now known as *Iyngipicus auritus* (Eyton) has an earlier name, and should therefore be known as *Yungipicus moluccensis* (Gmelin). The names of four other woodpeckers are preoccupied and they, therefore, require changing as follows: *Iyngipicus pygmaeus* (Vigors) becomes *Yungipicus mitchellii* (Malherbe); *Dendropicos minutus* (Temminck) is here renamed *Dendropicos elachus*. *Campethera punctata* (Valenciennes) will now stand as *Campethera punctuligera* (Wagler); and *Gecinus striolatus* (Blyth) becomes *Picus xanthopygius* (Bonaparte). H. C. O.

ORNITHOLOGY. *Mutanda ornithologica. VI.* HARRY C. OBERHOLSER. Proc. Biol. Soc. Wash. 32: 21–22. Apr. 11, 1919.

The changes in the names of birds on account of preoccupation or overlooked earlier names here made concern five species. The bird commonly known as *Francolinus chinensis* (Müller) must now stand as *Francolinus pintadeanus* (Scopoli); *Totanus maculatus* (Tunstall) becomes *Totanus erythropus* (Pallas); *Cuculus canorus minor* Brehm is named *Cuculus canorus bangsi; Monasa nigra* (Müller) becomes *Monasa atra* (Boddaert); and *Alcedo grandis* Blyth is now to be called *Alcedo megalia*, nom. nov. H. C. O.

ORNITHOLOGY.—*A review of the plover genus Ochthodromus Reichenbach and its nearest allies.* HARRY C. OBERHOLSER. Trans Wis. Acad. Sci. 19: Pt. 1. 511–523. Dec., 1918.

The present study originated in the desire to determine the proper generic name for the plover commonly known as *Ochthodromus wilsonius* (Ord). It resulted in an examination of not only all the species commonly referred to the genus *Ochthodromus*, but some of other genera as well. The eleven species concerned are found to represent the following seven genera: *Eupoda* BRANDT, *Pernettyva* MATHEWS, *Pluviorhynchus* BONAPARTE, *Pagoa* MATHEWS, *Pagolla* MATHEWS, *Cirrepidesmus* BONAPARTE, and *Charadrius* LINNAEUS. The synonymy of each of these genera, together with its detailed characters and a discussion of its relationships and nomenclature forms the main portion of this paper. The chief changes from the conclusions of the latest reviser of the group are as follows: The generic name *Eupoda* BRANDT is used in place of *Eupodella* MATHEWS; the current genus *Podasocys* Coues is found to be inseparable from *Eupoda*, and its only species should, therefore, now stand as *Eupoda montana;* the subgenus *Pernettyva* MATHEWS, instituted as a subgenus for *Charadrius falklandicus* Latham, is raised to a full genus and includes *Ochthodromus bicinctus* (Jardine and Selby); the generic name *Pagolla* MATHEWS should replace *Ochthodromus* REICHENBACH because preoccupied by *Ochthedromus* LeConte, and its only species, therefore, becomes *Pagolla wilsonia* (Ord). H. C. O.

ORNITHOLOGY.—*Description of a new subspecies of Piranga hepatica Swainson.* HARRY C. OBERHOLSER. Auk 36: 74–80. January, 1919.

The original description of *Piranga hepatica* was based on a specimen from the State of Hidalgo, Mexico, and the typical race of the species is, therefore, that from central Mexico. Birds from more northern localities now prove to be subspecifically different in their larger size and darker coloration. They form, therefore, an additional new subspecies, *Piranga hepatica oreophasma,* which ranges from western Jalisco, Mexico, north to central western Texas and northwestern Arizona. H. C. O.

ORNITHOLOGY.—*Description of an interesting new Junco from Lower California.* HARRY C. OBERHOLSER. Condor 21: 119–120. June 6, 1919.

The form of the genus *Junco* inhabiting the Hanson Laguna Mountains in northern Lower California is of considerable interest, since it

forms the connecting link between *Junco oreganus thurberi* of California, and *Junco oreganus townsendi* of the San Pedro Martir Mountains in Lower California, and indicates that the latter is, without doubt, a subspecies. Confined as it is to this single group of mountains and possessed of sufficiently distinctive characters, it is found to be subspecifically distinct from all the other known forms of the genus and is, therefore, named *Junco oreganus pontilis*. H. C. O.

ORNITHOLOGY.—*Fourth annual list of proposed changes in the A. O. U. check list of North American birds.* HARRY C. OBERHOLSER. Auk 36: 266–273. 1919.

The Fourth Annual list of proposed additions and changes made for zoological reasons in the names of North American birds includes everything pertinent up to December 31, 1918, inclusive. The total number of additions and changes amount to 51, the additions being 26 subspecies, 2 species, 1 subgenus, and 1 genus. The rejections and eliminations from the list total 19, of which the eliminations of subspecies amount to 5, species 2, and genera 2. This leaves a net gain of 21 species and subspecies. H. C. O.

ORNITHOLOGY.—*A revision of the subspecies of the white-collared kingfisher, Sauropatis chloris (Boddaert).* HARRY C. OBERHOLSER. Proc. U. S. Nat. Mus. 55: 351–395. 1919.

Birds allied to *Sauropatis chloris* present a difficult problem to the systematist, chiefly because of the great amount of variation, sexual, seasonal, and individual, in both size and color. They seem to represent a genus distinct from *Halcyon*, in which group they have usually been placed. Most of them are subspecies of *Sauropatis chloris*, although a number now thus regarded have heretofore been considered distinct species. As here understood the species *Sauropatis chloris* ranges from the Philippine Islands, India, and Abyssinia, south to Java and northern Australia, and east to the Fiji Islands. The number of subspecies here recognized is 24, and it is interesting to note that of these only six, including three found in Australia, are continental in distribution. Each is treated more or less at length, and in most cases, with the addition of tables of measurements. The following new subspecies are described: *Sauropatis chloris palmeri* from Java; *Sauropatis chloris azela* from Engano Island, western Sumatra; *Sauropatis chloris chloroptera* from Simalur Island, western Sumatra; *Sauropatis chloris amphiryta* from Nias Island, western Sumatra; and *Sauropatis chloris hyperpontia* from Vaté Island in the New Hebrides group. H. C. O.

CHEMICAL TECHNOLOGY.—*The identification of "stones" in glass.* (Geophysical Lab. Papers on Optical Glass No. 4.) N. L. Bowen. Journ. Amer. Ceramic Soc. 1: 594–605. Sept. 1918.

The petrographic microscope is a convenient and efficient instrument for the determination of the nature and origin of "stones" or crystalline particles occurring in glass. Stones are divided into four classes: (1) pot stones, (2) batch stones, (3) crown drops, (4) devitrification stones. These classes have distinctive features of structure and texture that are revealed by the microscope. Moreover, the crystalline phases contained in stones can be identified by a determination of their optical properties. The results of a study of stones by these methods are given in this paper. N. L. B.

CHEMICAL TECHNOLOGY.—*The condition of arsenic in glass and its rôle in glass-making.* (Geophysical Lab. Papers on Optical Glass No. 6.) E. T. Allen and E. G. Zies. Journ. Amer. Ceramic Soc. 1: 787–790. Nov., 1918.

Analyses show that in all the glasses tested, both plate and optical glasses, the major part of the arsenic present exists in the pentavalent state, but nevertheless a portion exists in the trivalent state. It appears that arsenic trioxide is oxidized at a low temperature and the product formed is stable enough to remain until a high temperature is reached and the glass becomes fluid, when it slowly dissociates into oxygen and arsenic trioxide, both of which aid in the fining. E. T. A.

CHEMICAL TECHNOLOGY.—*Constitution and microstructure of silica brick and changes involved through repeated burnings at high temperature.* Herbert Insley and A. A. Klein. Bur. Stand. Tech. Paper 124. Pp. 31. pls. 10. 1919.

The investigation involves a petrographic microscopic study of test cubes and commercial silica brick, some of which had received repeated burnings by use in kilns. Quartz, cristobalite, and tridymite are the main constituents. Small amounts of pseudowollastonite and glass are present. Long burning at temperatures slightly less than 1470°C. causes the formation of a large percentage of tridymite. Cristobalite characterizes higher burned brick. Quartz first inverts to cristobalite in the fine grained ground mass and along cracks caused by shattering on heating, and then to tridymite if the temperature does not exceed 1470°C. The lime added in grinding aids more as a flux than as a bond. Most of the cementing action in the burned product comes from the interlocking of the quartz, cristobalite, and tridymite crystals. H. I.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

BOTANICAL SOCIETY OF WASHINGTON

136TH MEETING

The 136th regular meeting of the Botanical Society of Washington was held in the Assembly Hall of the Cosmos Club at 8 p.m., Tuesday, May 6, 1919, forty-three members and two guests being present. The program consisted of the following papers:

Agricultural explorations of Frank N. Meyer (with lantern): DAVID G. FAIRCHILD. The speaker gave a brief account of the life and work of Mr. Meyer, illustrating his talk by lantern slides made from pictures taken by the explorer in China and other parts of Asia. Meyer was a Hollander by birth and spent his childhood among the gardens of Amsterdam, rising through his own talents to be the assistant of Hugo de Vries. His passion for travel took him on foot across the Alps and into Italy to see the orange groves and vineyards of the Mediterranean and later led him to explore America and northern Mexico on foot. His first expedition in the years 1905-8 was into North China, Manchuria, and northern Korea; his second, in 1909-11, through the Caucasus, Russian Turkestan, Chinese Turkestan, and Siberia; his third, in 1912-15, through northwestern China into the Kansu Province to the borders of Tibet, and his last expedition in search of plants began in 1916 when he went in quest of the wild pear forests in the region of Jehol, north of Peking, and the region around Ichang. He was caught at Ichang by the revolution and for many months was unable to escape. The confinement and uncertainty with regard to the great war, together with an attack of illness, had by this time combined to bring on a recurrence of a former attack of what amounted to nervous prostration, and before he could reach the encouraging companionship of people of his own class he was drowned in the Yangtze River near the town of Wu Hu, thirty miles north of Nanking. He has sent in hundreds of shipments of living cuttings and thousands of sacks filled with seeds of the useful plants of the countries through which he traveled, which are growing successfully in American fields and orchards, and has rendered great service to our horticulture by showing us what the Chinese have done to improve their native fruits.

Agricultural explorations in Guatemala (with lantern): WILSON POPENOE. The avocado is being planted commercially in California

and Florida, and its cultivation seems likely to become important in those States. In order that this new industry may be built upon solid foundations the Department of Agriculture, through the Office of Foreign Seed and Plant Introduction, has undertaken to conduct an exploration of those parts of tropical America where avocados are grown, for the purpose of obtaining the best available varieties as well as information regarding the requirements of the tree. The work in Guatemala, which extended over sixteen months in 1916 and 1917, resulted in the introduction of about 25 new and promising sorts.

The avocado is the principal fruit tree of the Guatemalan highlands, and ranks alongside the banana as a source of human food. The Guatemalan Indians use it largely in the place of meat. The tree is found in Guatemala at all elevations between sea-level and 8500 feet, at which latter altitude severe frosts occur. It is significant that avocados are grown in regions which are considered too cold for the orange, the latter fruit not being found above 7500 feet.

In addition to avocados, numerous other plants were obtained and introduced into the United States. These include several varieties of the chayote, a promising new vegetable for the South; the large-fruited Guatemalan haw, *Crataegus stipulosa;* the Central American cherry, *Prunus salicifolia;* choice varieties of the cherimoya for cultivation in California; a beautiful dwarf Chamaedorea which gives promise of being valuable as a house plant; two new dahlias, one a double-flowered tree dahlia which has been named *D. maxonii*, and the other a smaller plant, considered by W. E. Safford, who has named it *D. popenovii* to be one of the ancestors of the cultivated race of cactus dahlias; the beautiful blue-flowered Guatemalan lignum-vitae, *Guaiacum guatemalense,* which promises to do well in Florida; a new blue-flowered Salvia; and the little-known ilama, *Annona diversifolia,* a fruit which resembles the cherimoya and deserves to be cultivated in all tropical countries.

Carbon monoxide, a respiration product of Nereocystis luetkeana: SETH C. LANGDON and W. R. GAILEY (by invitation). The data contained in this paper were obtained at Puget Sound Marine Station in an investigation to determine if the carbon monoxide present in the pneumatocysts of the giant Pacific Coast kelp was an intermediate step in photosynthesis or a respiratory product. It was found that carbon monoxide was formed only when oxygen was present in the gas. The carbon monoxide was produced just as readily in the dark as in the light, hence its formation is related to respiration rather than to anabolic processes.

SPECIAL MEETING

The Botanical Society of Washington met at the Cosmos Club at 8 p.m., July 1, 1919, in special session in honor of Dr. A. D. COTTON, Royal Botanical Garden, Kew, England, Pathologist to the Board of Agriculture and Fisheries of England and Wales; Dr. GEO. H. PETHYBRIDGE, Economic Botanist to the Department of Agriculture and Tech-

nical Instruction of Ireland; and Dr. H. M. QUANJER, Plant Pathologist of the Institute for Phytopathology at Wageningen, Holland.

In response to an informal welcome by the President of the Society, Dr. KARL F. KELLERMAN, Dr. COTTON told the Society of the condition of botanical work in England and the effect of the war on the universities and the research laboratories. While serious losses to the personnel have come through the war, economic work has been stimulated. A research institute and an institute of applied botany have been established at Rothamsted. The British Mycological Society is more and more recognizing plant pathology.

Dr. PETHYBRIDGE explained that the war had stimulated a great development of food production in Ireland and that it had brought a recognition of the value of economic biological work. There is a small but active group of men in Ireland interested in natural history.

Dr. QUANJER called attention to the fact that Holland is a small country, being only about one-one hundred and sixtieth of the United States, yet it has produced in the past and present a goodly number of botanists and has several well-developed university departments of botany. After referring briefly to the botanical work of Lotsy, Oudemann, De Vries, Beyerinck, Treub, Ritzema Bos, Wakker, Van Hall, and others, he discussed the difficult group of plant diseases which includes mosaic of tobacco, leaf-roll and mosaic of potato, the Sereh disease of sugar cane, a dwarfing of a Japanese mulberry, and an infectious mosaic of the ornamental Abutilon. These diseases, he said, are probably due to ultra-microscopic organisms.

CHAS. E. CHAMBLISS, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

MATTERS OF SCIENTIFIC INTEREST IN CONGRESS[1]

The Finance Committee of the Senate, which has had before it the bill for a tariff on scientific supplies (H. R. 7785), decided on October 3 to postpone all revenue and tariff matters until after the treaty of peace had been acted upon.

During the hearings on the bill the Tariff Commission prepared a report entitled *Information concerning scientific instruments,* which has been recently published. The report brings together a large number of opinions and arguments concerning the tariff on scientific supplies, received from various sections of the Bureau of Standards, from manufacturers of instruments of all kinds, and from universities and organizations.

Two distinct questions are involved: (1) Should Congress repeal the privilege, now granted to institutions of learning, of importing supplies free of duty? (2) Should the present rates be increased and imported articles now on the free list be taxed?

The opinions quoted are not analyzed in the report, but the following brief outline will indicate that those interested are still far from being in agreement. (Definite recommendations only are counted.)

(1) Of eleven university professors quoted, one favors and ten oppose repeal of the duty-free clause. Of twelve opinions from the Bureau of Standards, five favor and seven oppose repeal. Of seven manufacturers quoted on this subject six favor and one opposes repeal. The Council of the American Chemical Society is quoted in favor of repeal of the duty-free clause, "for a reasonable period of years, at least."

(2) Opinions on the subject of the imposition and increase of tariff rates on scientific supplies are quoted as follows: Ten manufacturers, all in favor of higher tariff; eleven sections of the Bureau of Standards, seven in favor and four against. The Commission believes that "the extremely diverse nature of the products falling under such a general designation as 'scientific instruments' renders general statements concerning the entire group of little value for the purpose of deciding on any rates of duty related to the competitive conditions which affect individual instruments."

The report also discusses in a general way the status of the domestic industry, imports and exports, tariff history, competitive conditions, and war developments.

A conference of campaign committees, delegates from affiliated engineering, architects', and constructors' societies, and other interested parties, is planned for some time in November, to give active support to the JONES-REAVIS bill for a National Department of Public Works.

[1] Preceding report: This JOURNAL. 9: 535. 1919.

On October 6 Mr. FRANCE, chairman of the Senate Committee on Public Health and National Quarantine, asked unanimous consent to consider S. J. Res. 76, providing for an investigation of the cause and methods of prevention of influenza and allied diseases. Mr. SMOOT objected, and no action was taken on the resolution.

The Senate resolution concerning the Botanic Garden (S. Res. 165) was taken from the table on August 23 and referred to the Committee on the Library, together with the report of the Fine Arts Commission. This report recommends the acquisition of 400 acres on Mount Hamilton, in the northeastern quarter of the District, as a site for "an adequate national botanic garden and arboretum" It will be recalled that the earliest scientific society in the District of Columbia, the Columbian Institute, organized in 1816, was the founder of the Botanic Garden, which was afterwards turned over to the Federal Government but still occupies its original grounds at the western base of Capitol Hill.

NOTES

The United States Geological Survey is about to supervise extensive topographic mapping in the West Indies. The Republics of Santo Domingo and Haiti have made appropriations sufficient to complete the surveys of their countries and have requested the Geological Survey to take charge of the work and to furnish the technical personnel. It is probable that Porto Rico and the Republic of Cuba will take similar action. In order to provide for the administration of this work a Division of West Indian Surveys has been created in the Topographic Branch. Lieut. Col. GLENN S. SMITH has been relieved from his duties in connection with military surveys and has been designated as Topographic Engineer in Charge of the new division. Field work in the Dominican Republic has already been started with an organization of five parties having a force of approximately sixty men which will be gradually increased to ten parties as the work progresses. It is expected that the survey of this Republic will be completed within four years.

The glass work and the chemical part of the cement investigation work of the Bureau of Standards which has been located for several years at the U. S. Arsenal buildings at 40th and Butler Streets, Pittsburgh, Pennsylvania, has been transferred to Washington. Mr. P. H. BATES, director of the Pittsburgh branch, is now located in the new Industrial Building of the Bureau. Mr. A. V. BLEININGER, chief ceramic chemist of the Bureau, will move to Washington in the near future.

The following educational courses are being given at the Bureau of Standards this winter: *A. Advanced theoretical mechanics*, W. S. GORTON; *B. Harmonic functions*, D. R. HARPER; *C. Introduction to mathematical physics*, L. B. TUCKERMAN; *D. Thermodynamics*, L. H. ADAMS; *E. Colloidal chemistry*, W. D. BANCROFT. Dr. C. W. KANOLT is chairman of the committee in charge.

Mr. JOHN BOYLE, JR., assistant examiner in the Patent Office, has resigned his position and will open an office in Washington for the practice of patent law.

Dr. F. C. BROWN, formerly associate professor of physics at the University of Iowa, has been appointed technical assistant to the director of the Bureau of Standards. During the war he was commissioned major in the Ordnance Department of the Army, and was engaged in research on problems of aircraft armament.

Mr. E. R. CLARK, of the Bureau of Standards, has resigned to accept a position with the Standard Textile Products Company of New York City.

Mr. JOHN B. FERGUSON has presented his resignation from the Geophysical Laboratory, Carnegie Institution of Washington, to be in effect November 1, and has accepted a research position with the Western Electric Company in New York City.

Messrs. A. N. FINN and L. J. GUREVICH, of the Bureau of Standards, have resigned to accept positions as Chief of the Technical Section of the Development Department, and Research Metallurgist, respectively, with the Hydraulic Pressed Steel Company of Cleveland, Ohio.

Dr. H. D. GIBBS, of the Bureau of Chemistry, has resigned to take up work with E. I. du Pont de Nemours and Company, of Wilmington, Delaware.

Mr. H. D. HOLLER has resigned from the Bureau of Standards and is now at the Parlin Laboratory of E. I. du Pont de Nemours and Company, of Wilmington, Delaware.

Mr. F. J. KATZ has been granted leave of absence from the Mineral Resources division of the U. S. Geological Survey in order to accept an appointment as Expert Special Agent in charge of Mines and Quarries for the Bureau of the Census. This arrangement is to insure close and effective coöperation between the two bureaus in the Fourteenth Census.

Mr. WILLIS T. LEE, geologist of the Geological Survey, will be absent from Washington until February, 1920, in order to deliver a course of lectures at Yale University.

Mr. RICHARD B. MOORE, until recently stationed at the Bureau of Mines' experiment station at Golden, Colorado, has been appointed chief chemist of the Bureau, to succeed Dr. C. L. PARSONS, resigned.

MR. J. G. RILEY, formerly with the Bureau of Chemistry, and recently Captain in the Sanitary Corps, is now in the laboratory of the Bureau of Internal Revenue, Treasury Department.

Mr. F. J. SCHLINK, a member of the staff of the Bureau of Standards since 1913, and for the past two years technical assistant to the Director, has resigned to carry on physical research for the Firestone Tire and Rubber Company of Akron, Ohio. Mr. Schlink recently received an award of the Edward Longstreth Medal of the Franklin Institute for his invention of an improved type of weighing scale.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 9 NOVEMBER 19, 1919 No. 19

PHYSICAL CHEMISTRY.—*The nature of the forces between atoms in solids.*[1] RALPH W. G. WYCKOFF, Geophysical Laboratory, Carnegie Institution of Washington.

The study of the arrangement of the atoms within a crystalline body and especially of variations in these arrangements with changes in the physical conditions of the solid, such as temperature and pressure, when taken in connection with the knowledge which has been accumulating concerning the nature of the atom, should give considerable information concerning the kinds of forces operating between atoms and between molecules. With this in mind the determination of the structures of a number of typical compounds was undertaken by the author about two years ago in the chemical laboratory of Cornell University.

It seems possible to arrange all crystalline solids in a number of groups according to the nature of the forces between their atoms. The general outline of such a classification is presented in this discussion. Because of the numerous speculations which have been introduced into recent discussions of the structure of the atom, it has seemed advisable to present the point of view which has served as a basis for this classification. The first part of this paper is given up to such a presentation.

J. J. Thomson,[2] G. N. Lewis,[3] and W. Kossel[4] have applied the present knowledge of the structure of the atom to a consideration of the nature of the forces of chemical combination. In developing the following discussion extensive use was made of the first

[1] This paper was written in February, 1919, but was still in manuscript when Langmuir's paper on a similar subject appeared (June, 1919).

[2] J. J. THOMSON, *The forces between atoms and chemical affinity.* Phil. Mag. (6) 27: 757–789. 1914.

[3] G. N. LEWIS, *The atom and the molecule.* Journ. Amer. Chem. Soc. 38: 762–785. 1916.

[4] W. KOSSEL, *Ueber Molekülbildung als Frage des Atombaus.* Ann. d. Physik (4) 49: 229–362. 1916.

of these papers. Recently I. Langmuir[5] has extended the theory of G. N. Lewis and has also tried to obtain from purely chemical considerations information about the more intimate structure of the atom. A. L. Parson[6] has applied his "magneton" theory of the atom to an explanation of chemical forces.

THE STRUCTURE OF THE ATOM

The "nucleus atom."—An accurate relation has been shown to exist between the wave lengths of the X-rays characteristic of the various elements and their order numbers in the periodic table.[7] This relation was discovered after the importance of this order number, known as the "atomic number," had already been urged.[8] Its bearing on the structure of the atom will be seen from the following facts.

If alpha particles are shot at a substance, a certain number of them will suffer a large change in direction. The "scattering" (change in direction) actually observed in the case of the various elements is that which would be expected if the atom possessed at its center a minute positively charged nucleus.[9] Experiments indicate that this charge has a magnitude Ne, where e is the charge on the electron and N is the atomic number.[10] Further, a study of the disintegration products of uranium and thorium shows clearly the variation of the chemical properties with variations in the nuclear charge.[11] These facts

[5] I. Langmuir, *The arrangement of electrons in atoms and molecules.* Journ. Amer. Chem. Soc. 41: 868–934. 1919.

[6] A. L. Parson, *A magneton theory of the structure of the atom.* Smithsonian Misc. Coll. 65: No. 11 (Publication No. 2371). 1915.

[7] H. G. J. Moseley, Phil. Mag. (6) 27: 703–713. 1914. If N is the order number of the elements, beginning with hydrogen as one, helium as two, lithium as three, etc.; ν the frequency of the corresponding lines in the X-ray spectra, A a constant which is the same for all elements; and b a similar constant having a value less than unity, then

$$\nu = A(N-b)^2.$$

[8] A. van den Broek, Physik. Zeits. 14: 32–41. 1913.

[9] E. Rutherford, Phil. Mag. (6) 21: 669–688. 1911; etc.

[10] H. Geiger, Proc. Roy. Soc. A. 83: 492. 1910.

[11] F. Soddy. *The chemistry of the radio-elements.* II. *The radio-elements and the periodic law,* p. 2. 1914. The loss of an alpha particle (doubly positive helium-atom) decreases the nuclear charge by two units producing an element placed two positions to the left in the periodic table. The loss of a beta particle (an electron) produces a shift of one unit in the opposite direction.

are most simply explained by considering the atom to be possessed of a very small nucleus carrying a positive charge equal to its atomic number. That the electron is a constituent of all matter can no longer be doubted. Then, since the atom as a whole is electrically neutral, enough electrons to neutralize the nuclear charge must be arranged about the central nucleus.[9] Thus the hydrogen atom is a small positive nucleus bearing a single positive charge and accompanied by a single electron; the helium atom is a doubly charged nucleus accompanied by two electrons; and so forth.

Loosely-bound electrons.—Some of the electrons in an atom may be expected to be more tightly bound than others. Close to the positively charged nucleus the electrical forces (and presumably also the magnetic forces) should be much stronger than farther away from the nucleus. Consequently those electrons which are close to the center of the atom will be held with greater force than the more distant electrons.

There are numerous indications[12] that the atoms do contain a small number of more or less weakly bound electrons. The application of the electron theory to the dispersion of radiation indicates the existence of such electrons. By using the relations which have been developed for the theory of dispersion it is possible to calculate roughly the number of dispersing systems in each molecule. If such a calculation is carried out for quartz, for instance, it is found that each molecule possesses three to four, probably four, "dispersion electrons." These calculations must be inexact, however, because the proper application of the expressions used requires a knowledge of all the vibrating systems in the molecule. Experimental difficulties, especially in the extreme ultra-violet, make this impossible.

Studies upon the absorption of light and the optical properties of metals furnish similar results. Metallic conduction is assumed to be due to electrons which possess a certain amount of freedom of movement. Then there are those electrons which, as is well known, can be liberated by light and heat; these also

[12] CAMPBELL. *Modern electrical theory.*

must be rather weakly bound. The positive rays are atoms which have lost a few electrons. Perhaps the strongest evidence, at any rate from the point of view of the chemist, that atoms possess a small number of loosely held electrons is furnished by the phenomenon of electrolytic dissociation. Since the magnitude of the electrical charges concerned is the same as that of the charge on the electron, the conclusion can hardly be avoided that a few electrons are involved. It is the natural thing to identify them with the "dispersion electrons" already mentioned. These outside rather weakly bound electrons are the ones involved in chemical changes.

Arrangement of electrons.- No real information is available concerning the exact arrangement of the electrons in an atom. These electrons must either be in motion about the nucleus (the revolving-electron type) or else they must be held in equilibrium positions about the center (the stationary-electron type). There are serious difficulties in the way of either arrangement.[13] Since the loosely bound electrons are the only ones involved in chemical reactions, the exact arrangement of the inner electrons is a matter of secondary importance to the chemist, at least for the present.[14]

From the standpoint of the chemist the stationary-electron atom seems simpler because its qualitative application is easier. This application can be made with either type of atom, however, and in the present state of our knowledge one is quite justified in imagining and using *for chemical purposes* whichever type of

[13] It may be of interest to chemists to restate the most obvious of these objections. If the electrons are in revolution about the nucleus and if light is an electromagnetic phenomenon, as it is firmly believed to be, then a continuous radiation of energy from the atom as a result of this motion would be expected. In a comparatively short time the atom would "run down," disintegrate. This may or may not be a fallacious argument. On the other hand, in the case of the stationary-electron atom, unless a hitherto unknown force of repulsion is assumed, it is hard to see why the negatively charged electrons do not fall into the positively charged nucleus and become neutralized.

[14] Also since chemical changes affect only the outside electrons, it is quite clear that chemical facts can present only the most indirect information concerning the inside electrons of an atom.

atom model meets his fancy (always remembering that his particular type of atom is only a convenience).[15]

Arrangement of outside electrons.—Although we are unable at the present time to determine the general arrangement of the electrons within the atom, the facts of chemistry furnish consider-

[15] It has been found *convenient* to picture an atom, the inner electrons of which are in rapid revolution, the outer electrons of which might be held in positions of equilibrium between the atoms in a molecule.

Langmuir (see note 5, p. 566) has suggested an ingenious arrangement for the electrons in a stationary model. The examples of the application of his model, however, to chemical compounds are those which would be equally well satisfied by any type of atom of the kind described above As already stated, chemical facts, simply because they involve only the outside electrons, cannot give direct information concerning the arrangement of the inner electrons. The stationary- and revolving-electron atoms might differ from one another in the nature of the electrical fields surrounding the atom. The electrical fields about the revolving-electron atom would be expected to be quite uniform while those about the other type might be clustered in patches In the Stark atom (*Prinz d Atomdynamik*, III) the "positive electrification" was grouped in patches and electrons took up equilibrium positions about these patches. It is not evident whether a definite choice between the two atom types can ever be made upon these grounds

Langmuir has urged that the existence of charcoals and similar porous substances having the form of solids of large *apparent* volume, where each atom of carbon (taking charcoal to be specific) is surrounded by fewer than four carbon atoms, is a proof that the electrons are stationary within the atom. This does not necessarily follow. In a structure of this sort the valence bonds which were linked up with other atoms in the formation of wood are, in the charcoal, partly or completely saturated by holding adsorbed gas (as will be seen later, adsorbed gas is probably held to charcoal and similar substances by *primary valence bonds*). As indicated by Bohr (Phil. Mag. (6) 26: 857. 1916) and discussed by Kossel (*op. cit.*) the four outside electrons in a revolving-electron atom in the case of carbon would be expected to place themselves, if possible, at the corners of a tetrahedron. As a consequence of these facts the large apparent volume of charcoal is not a proof of the inherently *directed* nature of the valence bonds of carbon. Many sulfides of large apparent volume are known which, when heated to a certain temperature, will suffer a rather sudden change in shape (and apparent volume), *i. e.*, they crumble. This quite possibly is due to the loss of adsorbed gas.

These objections are urged, not as proofs that the electrons are not stationary, but simply as showing that the evidence in favor of their stationary nature is not conclusive. The experiments of Hull (cited by Langmuir, *op. cit.* p. 869) are inconclusive. As S. Nishikawa has pointed out, the effects which led Hull to believe that electrons occupy definite positions in the crystal lattice are in some cases similar to those effects which would be expected to result from the thermal agitation of the atoms in the crystal. The best way to determine whether or not the effect is real would be to make the X-ray studies at a point where the specific heat is very small. The author hopes to make such a study in the near future.

able information concerning the outermost ones. As we pass along the periodic table horizontally from left to right, each atom differs from the one preceding it in carrying a nuclear charge greater by one and hence in possessing one more electron.[10] It is seen that with simple atoms (short series of the periodic table) the general characteristics of an atom repeat themselves after the addition of eight electrons: lithium and sodium are similar. With the long periods eighteen electrons (thirty-two in the last complete series) must be added before there is a complete repetition of properties. Three elements, those in the eighth group, exhibit a similar valence, so that there are really only twice eight kinds of valence (valence groups). There is, however, a partial repetition in the long periods after eight valence groups have been passed over. The sub-group elements show a valence similar to that of the primary elements: copper, silver and gold resemble the alkalies.

Radio-active phenomena and more especially the whole subject of electrochemistry emphasize the intimate connection between valence and the electron. The alkalies ionize losing one electron, the alkaline earths lose two; the elements of the oxygen group tend to acquire two, the halogens one; and so on. In 1904 Abegg[16] pointed out that the sum of what we choose to call the maximum positive and negative valences of an element is always equal to eight. Eight is the number involved in the recurrence of properties.

All of this seems to point clearly to some sort of repetition of the configuration of the outside electrons characteristic of the atom after the addition of eight outside electrons.[17] The repetition of properties is so striking that one is forced to the conclusion that when a certain definite number of electrons has been added to the outside of the atom, the force fields about the atom, except those resulting from the unneutralized charges upon the nucleus, become practically negligible. If hydrogen is the simplest element, this definite number of electrons in the case of the very simple elements (first short period of the table) is two. For the other simple elements it is eight. The heavier

[16] R. ABEGG. Zeits. anorg. Chem. 39: 330. 1904.

[17] See references 2, 3, and 6, on page 565.

elements require twice eight additions to "close" the atomic fields effectively. Then an atom of an alkali metal has one outside electron, an alkaline earth two, and so on until we reach the halogen with seven outside electrons and the next inert gas with eight outside electrons, starting a new group.[18]

Tendency to form clusters of eight.—The fact that oxygen with six outside electrons and chlorine with seven are negatively bi- and mono-valent, respectively, points to the *existence of a tendency to form clusters of eight electrons.*[19] In other words, in

[18] The simple elements would probably be represented as follows (if hydrogen is the simplest element and helium comes next):

Element	*Nuclear Charge*	*Electron Arrangement*
Hydrogen	1 positive	1 electron
Helium	2 positive	2 electrons forming a "closed cluster" of two
Lithium	3 positive	3 electrons: inside cluster of two, one outside electron
Glucinum	4 positive	4 electrons: inside cluster of two, two outside electrons
Boron	5 positive	5 electrons: inside cluster of two, three outside electrons
* * *	* * * *	* * * * * * * * * * *
Fluorine	9 positive	9 electrons: inside cluster of two, seven outside electrons
Neon	10 positive	10 electrons: inside cluster of two, "closed cluster" of eight
Sodium	11 positive	11 electrons: inside cluster of two, inside cluster of eight one outside electron
* * *	* * * *	* * * * * * * * * * *

Recently DEBYE (Physik. Zeits. **18**: 276. 1917), VEGARD (Ber. deutsch. phys. Ges. **19**: 328. 1917), and KROO (Physik. Zeits. **19**: 297. 1918) have tried to explain the K-series lines in the X-ray spectra of elements as due to an inside ring of *three* or *four* electrons. If this innermost ring preserves its character when we pass to the more complex atom, and if there are not one or two very light elements, as yet undiscovered, it is highly probable that this inside ring contains *two* electrons.

[19] A. L. PARSON, op. cit.

addition to the force holding the normal number of electrons to the nucleus, there is a force which causes the atoms to tend to add electrons beyond the number equal to the positive charge on the nucleus.

The force responsible for this tendency to form eights may be mainly an electrostatic attraction between positive and negative charges. This has been mentioned by Langmuir:[20] "According to ordinary potential theory, electrons uniformly distributed throughout a spherical shell should exert no forces on electrons inside the shell, but should repel those outside the shell as though the electrons in the shell were concentrated at the center. On the other hand, an electron in the spherical shell itself is repelled by the others in the shell as if one-half of the other electrons were removed altogether, while the second half were concentrated at the center. Thus, let us consider a carbon atom ($N = 6$) which has taken up 4 extra electrons and has completed its octet. An electron in the outside shell is thus attracted by the nucleus which has 6 positive charges, is repelled by the two electrons in the first shell as though they were concentrated at the center, and is repelled by the 8 electrons in the outside shell as if 4 of them were concentrated at the center. The repulsion of the electrons is thus only just able to neutralize the attraction by the nucleus, notwithstanding the fact that the whole atom has an excess of 4 negative charges." In the case of an oxygen atom ($N = 8$) which has acquired two electrons to complete its cluster of eight electrons, an electron in this outer cluster is attracted by the positive charge of eight units and is repelled by the equivalent of a negative charge of six units (by the two inner electrons and by the outer eight as if four were concentrated at the center). There is thus a strong extra attraction holding these additional electrons to the neutral oxygen atom. Fluorine would hold a single extra electron still more strongly.[21]

[20] Op cit, p. 909

[21] This discussion considered only the case where the electrons were distributed uniformly throughout a shell. A similar state of affairs will exist if the inside electrons are in revolution.

We can thus account for the existence of a tendency to add electrons beyond the number numerically equal to the charge on the nucleus but we are unable to state why electrons will add on to the atom to form clusters of eight rather than seven or nine or some other number[22] and why the formation of the cluster of eight results in such a great condensation of the fields of force about the atom. For our purposes the recognition of this tendency is all that is necessary.

Chemical valence.—Valence, then, *might* be defined simply as the tendency for the electrical (and probably also the magnetic)[6] fields to condense together to the greatest possible extent with the possession of an outside cluster of eight (also sometimes a cluster of two and sometimes a cluster of twice eight) electrons. The repetition of properties after the addition of eight electrons and the existence of a tendency to add electrons with the formation of clusters of eight were recognized by J. J. Thomson;[2] they underlie the application of the "magneton" atom of A. L. Parson[6] and the "cubical atom" of G. N. Lewis;[3] and they form the basis of what Langmuir[5] has chosen to call "the octet theory of valence," which is simply the application of this undeniable tendency to the representation of chemical compounds.[23]

Doublets.—Two electrical charges of opposite sign form a *doublet*, the moment of which with respect to an outside point (roughly, the effect of which upon an outside point) increases as the distance apart of the poles becomes greater.[24] Such doub-

[22] Langmuir's idea of cells suggests an explanation of this, but it must be borne in mind that his work only gives a possible geometrical arrangement of points of one kind about a point of a different kind and does not discuss how such a system could be physically stable. If the only forces of attraction and repulsion acting are those with which we are now familiar, such an atom model is unstable. As long as this theory is used simply as a convenient aid in picturing the atom it may prove useful to the chemist, but as yet no evidence has been presented to show that this model represents the actual arrangement of the electrons in the atom.

[23] As was earlier implied, these various discussions are not setting up new theories of valence but are indicating the explanation which the knowledge of the structure of the atom has to offer of the facts of valence as we have learned them.

[24] A doublet of this sort can be conveniently pictured. The fields of force between two electrical charges can be represented by lines (really tubes of force) passing from one to the other. The *number* of the lines serves as a measure of the intensity of the field. If the two charges are close together, the lines of force are for the

lets will exist within an atom possessing electrons and a positively charged nucleus.[25] The formation of the clusters of eight electrons so condenses together the lines of force about the atom that their moments with respect to other atoms are nearly negligible. Where the outside loosely bound electrons are concerned, the fields about the doublets become of the utmost importance in determining the chemical and physical properties of bodies.

Magnetic fields of the atom.—This discussion has taken no account of the magnetic fields about the atom. That atoms are possessed of fields of their own is shown by the effect of large outside fields upon the spectrum lines,—the Zeeman effect—and by various other lines of evidence.[26] It is probable that a detailed discussion of these magnetic effects would remove many of the difficulties arising from the application of such a theory as the present one. Certainly such a discussion must accompany any entirely general or quantitative theory. The "magneton" theory of A. L. Parson[6] is an attempt in this direction. Contradictions to some of the most commonly accepted ideas (such as the point-electron and the Rutherford type of atom) which Parson's theory presents make it simpler to neglect, at present, consideration of magnetic phenomena. It is probable that the magnetic forces influence in a marked degree the intensity of bonding between atoms but that their consideration will not introduce any new kinds of linkage.

Forces between atoms.—Conditions of equilibrium require the action of forces of attraction and repulsion. Uncertainties concerning the size of the atom make themselves felt in a consideration of the forces of *repulsion*. We find that the distance between the atoms in a solid[27] is of the order 10^{-8} cm. The actual

most part concentrated in the small space between the charges, so that the intensity of the field at any point (m) at a distance from both charges is slight. In other words, the moment of the doublet with respect to the point is small. If the separation of the charges is greater, the field will be more spread out, more lines of force will pass through m, and the moment of this new doublet with respect to m is much greater.

[25] J. J. Thomson, op. cit.

[26] See W. J. Humphreys. Science, N. S. 46: 273–279. 1917.

[27] W. H. Bragg and W. L. Bragg. *X-rays and crystal structure*, Chap. VII.

size of the atom may be very small compared with this distance. Atoms in a solid would then be held apart by some repulsive force, the intensity of which must decrease rapidly from the origin. Concerning its possible nature we have no inkling. Presumably the heat vibrations would aid this force. But the diameter of the atom, meaning the diameter of the outermost ring of electrons, may be comparable with the distance apart of the atoms. The tightly drawn-in fields about the closed groups of electrons make the atom, except for a few valency electrons, behave like an elastic solid, so that two atoms can interpenetrate only to an extent involving these outside electrons. This effect, together with the thermal agitation, is quite sufficient to explain the ordinary phenomena observed. The assumption of a further repulsive force, essential to the other theory, does not seem necessary. The view that the atoms are held apart simply as the result of their own impenetrability and their thermal vibration will therefore be used.

The influences of which we are aware that affect the combination of atoms one with another are then:

1. The electrostatic *attraction* between positively charged nuclei and negatively charged electrons.

2. The large condensation and drawing in of the fields of force which accompany the formation of certain clusters of electrons (two, eight or twice eight). The result of (1) and (2) is an apparent *tendency to* FORM *clusters of electrons.*

3. The thermal agitation of the atoms (and probably in certain cases groups of atoms acting together) which acts as a force of repulsion.

4. The magnetic fields (our ideas of which are at present of an indefinite nature).

Exterior structure of the elements.—An alkali metal results when the total number of electrons needed to form the "closed clusters," including the outermost "closed cluster," is 1 less than that required to neutralize the nuclear charge, *i. e.*, there is one outside or "left-over" electron. The closed cluster in the case of lithium contains fewer electrons than eight, presumably two. So few electrons can hardly be expected to draw

in very completely the fields about the atom. With sodium, possessing a single cluster of eight electrons, the fields are more condensed. Where clusters of twice-eight electrons are effective (potassium, rubidium, caesium) the outside fields become of little importance. This suggests an explanation for the marked difference in properties exhibited by the transition elements of a group. As the atom gets larger the detachable electrons become farther removed from the nucleus and consequently less tightly bound. Elements of the sub-group have a single cluster of eight so that, although they resemble the alkalies in having a single outside electron, the forces about the atom which tend to enmesh and hold the electron are very much greater.

The atoms of the other groups will be similarly constituted. Those of the second group possess two outside electrons, the third three, and so on, up through the eighth group.

For the eighth group the theory is not so simple. In this group there is a single cluster of eight electrons and no outside electrons. The atom is quite complex, however, and a single cluster of eight electrons is unable to close the fields completely. As a result the atom possesses considerable reactivity. The facts of chemistry show that, perhaps on account of the vigor of these forces, two and sometimes three of these electrons can be detached. The existence of three similar elements in this group is *conveniently* explained by the assumption that at this point, when the two additional electrons are added, rearrangements of the internal rings are more stable than the addition of an outside electron.[28]

The character of the rare-earth elements could be explained by an assumption like the last one, namely, that when this point in the periodic series is reached, the stable arrangements, for a number of successive increases in the nuclear charge, result

[28] The system is seen to be tending towards a more stable condition with each readjustment. The outside fields become more and more drawn in and the electrons become less loosely bound. This is shown by the transition in properties from iron, Fe″ (less stable) and Fe‴ (more stable), through cobalt, Co‴ (less stable) and Co″ (more stable), to nickel, Ni″ only.

The assumption made by Langmuir that ten electrons are necessary to form the first half of the larger closed groups is about as satisfactory. In the absence of any real information upon the subject either can be used.

from a rearrangement of the electrons among the interior rings rather than from the addition of electrons to the atom surface. But this assumption, in common with every other yet made regarding the arrangement of the electrons in the eighth-group and rare-earth metals, is not very satisfactory as a description of the real arrangement of the electrons in these atoms.

The behavior of hydrogen is interesting. In water solution of many of its compounds it behaves as if strongly "electropositive." This would indicate that it lost an electron with great readiness. But in most of its properties hydrogen acts like an element which holds on to electrons with great tenacity: its salts with weak anions are much less dissociated than the corresponding alkali salts; it occupies a position quite low in the electromotive series table; many of its compounds are volatile, and its diatomic molecule is very stable. This apparently anomalous behavior of many hydrogen compounds follows directly from the structure of its atom. As long as hydrogen possesses a single electron, it holds on to it energetically and tends to acquire another to close its fields; if the electron is removed, the only force exerted by the atom is due to the attraction of its single positive charge.

THE STRUCTURE OF CHEMICAL COMPOUNDS, PARTICULARLY SOLIDS

Polar and non-polar compounds.—All chemical compounds may be considered as included within the following extremes, compounds the constituent atoms of which are electrically

1. Charged,
2. Neutral.

If the atoms are charged, the compound is "polar;" if neutral, it is what is now called a "non-polar" compound.[29]

In a polar compound the tendency of the electronegative atom to complete a cluster of eight is so much greater than the attraction of the positive nucleus of the electropositive atom for the outside electrons that the electronegative atom is able to remove them completely.

[29] W. C. Bray and G. E. K. Branch. Journ. Amer. Chem. Soc. 35: 1440–1447. 1913.

A non-polar compound is held together by the entangling of the fields of force about the constituent atoms. No electron transfer occurs. Each atom may be considered as drawing electrons from another in the endeavor to complete a stable group. In such a union as this, one unit of valence is equivalent to two "free" chemical "links," that is, one chemical "bond" in the compound.[30] Such a non-polar compound would of course have to be formed between atoms which held their electrons with about equal intensity.

All gradations between these two extremes probably occur where the bonding electrons, taking up positions between the two atoms, may be thought of as belonging to both. Most compounds, especially in the vapor state, must lie in this intermediate class. A given compound is not necessarily polar or non-polar in all its states of aggregation; it may shift from one class toward the other. In the solid and liquid states the close proximity of other atoms has a strong influence upon the properties of a molecule.[31]

States of aggregation.—When the total attractive forces between the units (molecules) of a substance is less than the repellent forces of thermal agitation, the molecules will part from one another and the substance is said to be in the gaseous state. The less the attractive force compared with the thermal agitation, the more "perfect" will be the gas. A liquid results when these residual fields (stray doublet fields) just exceed the effects of the heat vibrations. When the fields become relatively very large and the atoms are able to take up definite positions, the substance solidifies. Of greatest importance in causing the

[30] J. J. Thomson (op. cit.) has indicated this fact. Using the idea of Faraday tubes of force, as he does, we would say that unless a cluster of eight is formed the valency electron, to be fixed in position, requires that it shall have tubes of force running to two atoms, one other besides the one to which it belongs. This will be quite evident when typical cases, chlorine and methane, have been considered.

[31] When molecules approach one another, there will be an interlocking of their stray fields. A certain weakening of the fields of the molecule itself will result. With doublets of large moment, where the separation of the charges is great, the fields will be spread out and the interlocking may be of marked effect upon the molecule.

individual molecules to stick together are the electrical doublets. The greater their moments the more important will be their effect upon neighboring atoms. Consequently polar compounds tend to be strongly aggregated. Nearly all such compounds are solids at ordinary temperatures. The lower the temperature the less the repulsion and the more the particles cling together. At a sufficiently low temperature, the absolute zero, a substance possessing even the smallest outside fields would be a solid simply because the heat motion of the atoms, and consequently their repulsion, vanishes.

The effect of the intensity of combination is complicated. If the bonding forces in the gas molecule of a particular compound are so large and the residual forces so small that the molecule remains a definite entity in the liquid and solid states, it will in general be true that the greater the bonding forces, the more bound-in will be the fields and the less will be the degree of condensation. If, on the other hand, we have a compound in which the molecule as we ordinarily understand it disappears in the condensed states, and the entire portion under consideration appears as one large molecule, it would seem to be true that the more intense the bonding the *more* condensed is the system.

Formation of molecules in non-polar substances.—At room temperature the molecule of chlorine is diatomic. The chlorine atom possesses seven outside electrons and the tendency to pick up one more and close the cluster is considerably greater than the repellent effect of the heat vibrations. The molecule can be represented somewhat as follows:[32]

[32] There is a certain interest and importance attached to the representation of compounds by the use of graphical formulas. The conventions in common use do not indicate the nature of the forces between atoms. The representation, by G. N. Lewis (op. cit.), of the *distribution* of the outside electrons between the atoms in chemical compounds is a distinct advance in the writing of graphical formulas. But his method has certain disadvantages. It is often tedious and, moreover, unless considerable space is devoted to the formula, it does not show the *positions*

each atom striving to claim an electron from the other. This arrangement will quite completely close the fields about the molecule as a whole and the diatomic chlorine molecule (Cl_2) will possess relatively little residual affinity. As the temperature is raised the increased energy results (1) in a larger vibration of the atoms within the molecule, and (2) more especially in the increased violence of the motion of the molecule as a whole. Thus there will come a time when some of the molecules will be traveling with so great a speed that the violence of their collisions will be sufficient to cause the splitting of the molecule. At this point we begin to have monatomic chlorine. The number of simpler molecules increases faster than the increase in temperature at a rate depending upon the importance of factor (1). The amplitudes of the atomic vibrations depend in an inverse ratio upon their weights and the intensity of the bonding. It is to be expected that the dissociation of a weak compound under the influence of heat will proceed at a faster rate than when the union is strong. Increase in temperature raises the reactivity because with larger intra-molecular vibrations the fields of force

of the electrons. The pictures used by Lewis and adopted by Langmuir give, as representations of space models, a truer idea of the actual state of affairs within compounds, but, by reason of their complexity, are not in most cases sufficiently useful to be practicable.

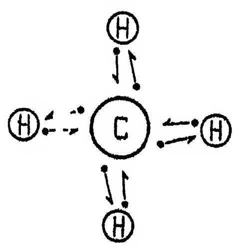
It has been found useful to designate the mode of combination, where this added information is of value, by the following modifications of the ordinary chemical "bonds." The passage of an electron from one atom to another is shown by a full-pointed arrow. Caesium chloride, in which the chlorine atom has captured the outside electron of the caesium atom, is $Cs \longrightarrow Cl$. The holding of an electron in an equilibrium position between two atoms, as in bromine vapor where each bromine atom of the bromine molecule is striving to acquire one electron from the other bromine atom, can be indicated by a half pointed arrow pointing in the *direction* of the displacement of the electron (as, $Br \rightleftharpoons Br$). If it is of advantage to know the approximate *amount* of this displacement, which serves of course as a measure of the doublet fields set up, this can be done by cutting the arrow with a dash at the approximate position of the electron. Thus A ——|—→ B would mean that B was drawing one of A's electrons with a pull sufficient to displace it to a position half the way towards B.

The diagrams given in the text are a combination of this method of representation with the idea of showing the distribution of all the outside electrons.

are gradually becoming more opened up and hence more readily broken up by other atoms.

As the temperature is lowered, if the pressure is made sufficiently high, that is, if as many molecules are furnished within a definite space as could possibly be needed, the tendency of the molecules to stick together will approach in value the tearing-apart tendency of the heat motion. The critical temperature is the point where these opposing tendencies are equal. At no higher temperature can the gas be liquefied; at all lower temperatures the substance can be condensed. As the temperature of the liquid is lowered the motion of the molecule becomes less and less till at a certain point the residual forces of attraction (stray fields) become able to hold the molecules in definite positions. This happens at the melting point. According to this view solid chlorine consists of molecules held together by stray fields. Valency forces are involved in holding the atoms together in the molecule.[33]

Methane is a substance of the same type. A molecule of methane may be represented thus:



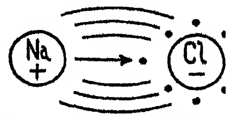
It has a normal dielectric constant and presumably does not possess any doublets of large moment.[2] This indicates that the tendencies of either carbon or hydrogen to acquire electrons

[33] It is possible that with the close proximity of other atoms, both the ingoing and the outgoing unions will not remain directed towards the same atom In that case each atom would be linked by primary valence with two atoms, each of which would be linked with other atoms and so on throughout the mass. With this state of affairs the molecule as ordinarily understood would lose its identity. The smallest unit, aside from the atoms themselves, becomes the entire mass. This is a possible structure for solid chlorine. There is at present no evidence in its favor. If this second view is correct the vapor subliming from the solid ought possibly to contain an appreciable number of monatomic molecules.

to complete the clusters are not nearly so great as the tenacity with which hydrogen and carbon retain electrons. The electrons consequently are not appreciably displaced from their equilibrium positions. The stray fields are relatively small and the gas liquefies at a rather low temperature. The chemical molecules preserve their identity in the liquid and solid states, being held to one another by the relatively slight secondary attraction.

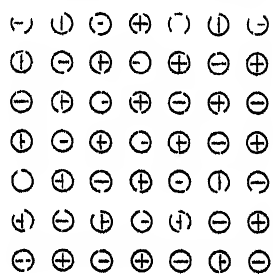
Carbon compounds in general are characterized by great stability, due to the intensity with which carbon clings to its electrons, and by the smallness of the residual attractions possessed by the molecules of such compounds. In passing horizontally along the periodic table, when carbon is reached the tendency to add electrons with the formation of a stable cluster is not as yet so great that carbon is able to capture electrons from other atoms, and consequently there are no doublets of large moment. The properties of organic compounds in general force the conclusion that in the solid and liquid states the chemical molecule remains just as definite an entity as in the vapor. Practically all but the simplest compounds are solids or liquids, in spite of the weakness of the residual forces, because such large molecules require a considerable amount of heat energy to produce even a small displacement.[34] Certain kinds of organic compounds, such as the alcohols, acids, and nitro- and nitrile-compounds, are more associated than would be expected. This is due to their possessing doublets of considerable moment.[2]

Formation of molecules in polar substances.—With compounds of the polar type the mechanism is quite different. The tendency of chlorine to acquire one electron is so great and the holding power of sodium for the one outside electron is so weak that in a molecule of sodium chloride vapor the electron may be considered to have gone over most of the way to the chlorine. A molecule of sodium chloride vapor may be represented thus:



[34] Information from the specific heats and from the variations in the specific heat with temperature should be of interest in this connection.

A doublet of very large moment exists in this molecule and sodium chloride vapor would be expected only at an elevated temperature. In the solid and liquid states each sodium atom (except those upon the surface), positively charged by the loss of an electron, is surrounded by several chlorine atoms, all negatively charged.[35] These other chlorine ions, each possessing a pull upon the sodium ion, will more or less completely tear apart the fields which in the gaseous state bind the sodium atom to one particular chlorine atom. Sodium chloride becomes a body of ions held together mainly by the electrostatic forces of attraction between opposite charges. A cross-section of a crystal of sodium chloride would appear thus:[36]



The gaseous molecule disappears quite completely. A study of the effect of a sodium chloride crystal upon X-rays leads to belief in such a structure.[37]

Concerning the liquid state of sodium chloride we know practically nothing. It would seem most reasonable to assume a structure similar to that possessed by the solid, with the added fact of mobility; that is, an agglomeration of an equal number of positive and negative ions. When such a solid sublimes, ions should appear in the space above.[38] In general all crystals made up of strongly electropositive and electronegative elements are

[35] Sodium chloride possesses absorption bands in the extreme infra-red which are produced by *charged* particles of *atomic* mass.

[36] This structure for sodium chloride and similar crystals has been suggested by STARK, *Prinz. d. Atomdynamik*, III. p. 193.

[37] W. H. and W. L. BRAGG. *X-rays and crystal structure.*

[38] The chemical molecule is in certain cases a natural consequence of the belief in atoms. It is not, however, in all cases a necessary consequence. If we are to imagine two or three atoms, each with a certain tendency to react, coming together,

of this type. Sodium nitrate and calcium carbonate[37] are examples. In these cases the nitrate and carbonate ions act as single units. Three factors are of importance in determining the crystal form of such substances:

1. The stable arrangement of points in space which correspond in charge and number with the ions of the substance.

2. The number and arrangement of the atoms making up the ions.

3. The volumes of the ions.

The sodium chloride arrangement is the simplest possible for the grouping of an equal number of positive and negative particles of about equal volume. Sodium nitrate and calcium carbonate have the same structure as sodium chloride, the nitrate and carbonate ions replacing the chlorine ions.

Valency compounds. Magnetite ($Fe''Fe'''_2O_4$) is an example of another general type of compound. In a crystal of magnetite each divalent iron atom is surrounded by four oxygen atoms, each trivalent iron atom by six oxygen atoms, and each oxygen

it is natural to suppose that they will combine together to form a definite whole - the molecule. This is what happens in the case of gases. The first actual evidence to show the existence of molecules came from the study of gases. This evidence is furnished by the Gay-Lussac Law of Volumes. The splendid success of the kinetic theory in describing the behavior of gases pointed in the same direction. When gas molecules had been shown to exist, a tendency to apply the idea of molecules to solids and liquids as well made its appearance. The extension of the gas laws to the case of dilute solutions showed that in this case the material of the dissolved substance is distributed thoughout the solvent in a molecular condition, that is, as single atoms or as groups of a few atoms together. Only in these two cases, gases and dilute solutions, have we sure evidence of the existence of molecules. Certain observations upon solutions of solids in solids would seem to indicate for them a structure similar to that possessed by liquid solutions The abnormal behavior of some pure liquids finds its simplest explanation in the assumption of a molecular structure. Because of this certainty of the existence of the molecule in gases and in solutions, and because with organic solids and liquids it is quite impossible to imagine any other than a molecular composition, chemists in general seem to have felt justified in concluding that all matter is molecular in structure. It is important to note that this conclusion is only an inference, in no way justified by experimental evidence, and that the recent evidence which has appeared, tending to show that certain kinds of solids and liquids are *not* made up in such a way that each piece consists of a large number of chemical molecules, is merely destroying some generally-held opinions and is not in any way contradictory to our previously acquired knowledge.

atom by four iron atoms.[39] The diamond, carborundum, certain oxides and sulfides, and presumably nitrides and carbides, are compounds of this kind. The elements which go to make these substances are not strongly electropositive or electronegative, so that no actual electron transfer takes place. Completely closed groups are not formed and each valence unit corresponds to two bonds. The atoms in such a crystal are held together by valency forces. The chemical molecule does not appear; the entire crystal behaves as a single chemical individual.

It is improbable that liquids of this sort can exist. Certainly such compounds cannot be vaporized without undergoing profound changes. It is possible that at elevated temperatures the electronegative element may be able to relieve the other of electrons. Such a substance, when existing in the liquid state, would belong to the class previously described, the polar type of compounds.

Metals belong to the polar type. Just as the close proximity of other atoms in the case of sodium chloride is sufficient to break up the fields binding one particular sodium atom and one particular chlorine atom, so in the metallic state the presence of other atoms breaks up the fields holding certain electrons to the metal ion. A metal may be considered as a compound of metal ion and electrons entirely similar to a liquid of the polar type, which is a compound of metal ion and negative ion. The peculiar properties characteristic of metals are due to the fact that the electrons as a result of their minute size are readily able to pass between the atoms. This mobility makes the mechanism within the metal resemble that within a fused electrolyte. The atoms in intermetallic compounds, which presumably exist as such only in the solid state, are held together by the same forces that hold metal ions together in the pure metal. If a certain grouping of atoms offers an especially marked condensation and drawing-in of the fields of force, that grouping will appear as one of these compounds.

Classification of crystalline solids.—The crystalline state furnishes the greatest condensation of the fields about the indi-

[39] W. H. Bragg. Phil Mag. (6) 30: 305. 1915. S. Nishikawa. Proc Tokyo Math. Phys. Soc. 8: 199. 1915.

vidual particles (atoms or molecules, depending upon the type of solid).[10] Three limiting types of crystalline solids may be said to exist:

1. *Molecule-forming compounds.* The atoms are held together in molecules by valency forces. The molecules, in turn, are held together in the solid by relatively weak stray fields. Compounds giving solids of this nature do not possess large doublets.

2. *Polar compounds.*— The atoms are held together by electrostatic attractions. The chemical molecule has disappeared.

3. *Valency compounds.*- The atoms are held together by valency forces. The molecule is the entire crystal.

Combinations of these classes and all transition stages between them are found. In sodium nitrate the nitrogen and oxygen atoms are held together by valency forces to form the nitrate ion. The combination between the sodium and the nitrate group is polar. The silver and mercury (mercurous and mercuric) halides are probably midway between (1) and (2). In a crystal of silver iodide, because of the vigor with which silver clings to the one electron, the electron may be considered as placed part way between the silver and the iodine atoms. The *molecules* of silver iodide are held together partly by the stray fields and partly by the fields of the doublet of relatively small moment.

A brief discussion of certain phenomena which illustrate the application of this point of view will now be given. Some of these subjects have been considered already from similar points of view.[11] They are given again either because they are especially helpful to an understanding of the previous discussion or because of their importance in the consideration of the structure of solids.

Dissociating Solvents.- The hydrides of the electronegative elements furnish the strongest dissociating solvents. Methane has been dealt with in detail. The fields of its molecule are quite

[40] If the substance is cooled very rapidly it may be impossible for the particles to arrange themselves in an orderly fashion The solid is then amorphous.

[41] E. C. C BALY. Journ. Amer. Chem Soc 37: 979-993. 1915; also papers in Trans. Chem. Soc. London. I. LANGMUIR. Journ Amer. Chem Soc. 38: 2221 2295. 1916; 39: 1848–1906. 1917; 40: 1361–1403. 1918. W. D. HARKINS, E. C. H. DAVIES and G. L. CLARK. Journ. Amer. Chem. Soc 39: 541-596. 1917.

thoroughly saturated. With ammonia the tendency for nitrogen to acquire electrons is so much greater than the ability of the hydrogen to hold them that the electron of hydrogen is displaced quite a distance towards the nitrogen atom. Doublets of very considerable moment are thus set up within the ammonia molecule and are of large effect upon other atoms or molecules nearby. In water, doublets of still greater moment are to be distinguished on account of the more pronounced tendency of oxygen to acquire electrons. In hydrogen fluoride the single doublet is of even greater moment.

In the water molecule each of the two doublets is of slightly greater moment than each of the three in ammonia. However, the fields about the molecule of water are much more important than those about the ammonia molecule largely because of the comparative simplicity of the former. The hydrogen atoms in ammonia must lie in three different directions; the water molecule requires at most two directions, and probably both hydrogens would be in a line (the symmetrical arrangement). Consequently the turning of the water molecule in order that it may exert its maximum effect is much simpler a process than the corresponding process for ammonia.[2] Concerning the fields about hydrogen fluoride there is relatively little information. The molecule is not much simpler than the molecule of water; the single doublet does not possess a very much greater moment than either of the doublets of the water molecule.

The fields about the water molecule seem to be the strongest of those considered. In liquid water the combination between two molecules due to the interlocking of these doublet fields draws in the fields so that those about the "dihydrol" molecule are much lessened. The dihydrol is a fairly stable compound. Such a liquid, in which combination with itself is possible, is said to be "associated." The fields are intense enough and sufficiently localized to make possible combination between two, occasionally more, molecules but not strong enough to cause solidification. Organic acids associate by reason of the intensity of the combinations between the —COOH groups of different molecules, and alcohols because of the association of —OH groups.

Adsorption.[42]—There will be fields of force upon the surfaces of all solids and all liquids. The molecules of the gas surrounding the solid likewise possess stray fields of greater or less importance. One of two things will happen to those gas molecules which strike the surface of the solid (or liquid).

1. If the molecule is moving so fast that its energy exceeds that necessary to hold together the two fields, it will be reflected from the surface with a loss in energy depending upon the stray forces.

2. Otherwise it will condense and be held upon the surface. The molecule may by reason of collisions from other molecules acquire enough energy to enable it again to leave the surface. The average life and the number of atoms upon the surface at any one time will depend upon the balance set up between these opposing tendencies. As a result of the condensation (adsorption) a new surface, really one of the adsorbed substance, is produced.

From this point of view adsorption is seen to depend upon the following factors:

1. The adsorbed substance. The greater the outside fields of the molecules, the higher will be the adsorption.

2. The adsorbing substance. Solids of the valency and polar (electrolyte) types should have large surface fields and should adsorb strongly. Those solids, the particles of which are held together by stray fields only (the organic type), will adsorb to only a slight extent if at all.

Solubility.—Solubility results from the entangling of the fields of force of the solute and solvent. The process is influenced by:

1. The intensity of the residual forces of the solvent. When these forces are large, the degree of association of the liquid will furnish a rough measure of the forces. With weaker non-associating liquids the boiling point, combined with the weight of the molecule, gives the desired information.

2. The intensity of the residual forces of the solute. The various kinds and degrees of these have been discussed under a consideration of various typical solids.

[42] I. LANGMUIR. Phys. Rev. 8: 149–176. 1916; Journ. Amer. Chem Soc. 40: 1361–1403. 1918.

It seems possible to state as a general rule that strong solvents (*i. e.*, those possessed of large external forces) dissolve strong solutes, while weak solvents dissolve weak solutes. Weak solutes are not usually markedly soluble in strong solvents nor is the reverse case true. Water dissolves electrolytes; carbon disulfide and benzene dissolve organic compounds; but electrolytes are not appreciably soluble in carbon disulfide or benzene, while water dissolves only those organic compounds which are possessed of large fields—the acids, alcohols, sugars and the like.

Solubility results, in fact, from a chemical reaction between solvent and solute. In order that marked solution can take place, it is necessary that the stray fields about the solvent and the dissolving substance shall each be strong enough to "open up" and make reactive the condensed systems of the other. A certain solubility can be considered to exist in all cases unless the temperature is carried too low. The ordinary tendency for the solute to "vaporize" into the liquid will be enhanced to an extent depending upon the added stray fields of the solvent.

The solubility of molecular compounds in non-associated liquids is perfectly straightforward. There will always be some solubility, increasing in amount as the solvent fields, which in such liquids are already pretty well opened up, become of increasing importance compared with those of the solute. In order that a substance may be strongly soluble in an associating liquid, it must possess fields great enough more or less to break up this association. Two types of solids have strong outside fields: valency compounds and electrolytes. The fields upon the surface of valency solids are due to the tendency of the surface atoms to complete their clusters of eight electrons. Except directly upon the surface, a valency compound is very thoroughly saturated. The surface atoms will be able to combine with the solvent molecules, but little action will result because of the much greater force within the solid material. Adsorption, rather than solution, results from this reaction. Electrolytes possess doublets of large moments which are able to open up to a large degree the fields of the solvent. The extent of the solution of an electrolyte depends upon

1. The degree of association of the solvent (which might be taken as a measure of the potential reactivity),

2. The moments of the doublets within the solid,

3. The stray fields within the solid.

In solids possessing multiply-charged ions the increase in the intensity of the binding fields would, where a condensing together of the fields is possible, be greater than the increase in the moments of the doublets. There would thus be a smaller tendency to dissolve. This tendency to condense together, which would ordinarily be found occurring with a double bonding, depends upon both the number and arrangement of the atoms within the solid. Calcium carbonate is only slightly soluble in water while sodium nitrate,[43] possessing the same structural arrangement, dissolves readily. If the ion possesses about it considerable fields, it may be able to form with the molecules of the solvent more or less short-lived compounds.

This point of view suggests for ionization a mechanism somewhat different from that usually accepted. A salt does not usually become ionized at the moment of solution; it is already ionized in the solid state. When a crystal of sodium chloride is added to water, ions, not molecules, are torn from the solid by the process of solution. These ions may, and will when there are enough of them present, combine temporarily to form sodium chloride molecules. The process of solution and ionization is not $\underset{\text{solid}}{\text{molecule}} \longrightarrow \underset{\text{solution}}{\text{molecule}} \longrightarrow \underset{\text{solution}}{\text{ions}}$, but $\underset{\text{solid}}{\text{ions}} \longrightarrow \underset{\text{solution}}{\text{ions}} \longrightarrow \underset{\text{solution}}{\text{molecule}}$.

Molecular Complexes.—Molecular complexes are formed by the interaction of the stray fields of simple compounds. Molecular compounds are formed when two molecules hold together. Complex ions result from the entangling of a simple ion by the fields of a "neutral" molecule.

Hydrates are typical *solid molecular compounds*. In order that such a compound shall be formed, it is essential that both

[43] The fact that the carbonate group, being a weak anion, is unable to draw the extra calcium electrons near to it with the production of the large doublets present in sodium nitrate is also of influence in reducing the solubility.

constituents shall be possessed of fairly large outside fields. In compounds where the binding electrons are held between the electropositive and electronegative portions, the fields are more condensed together and more stable than those of the extreme electrolytes. Complexes formed by them are more *stable* than those involving ionizing substances. The conditions for stability of a hydrate can be shown by an example. In a solution of zinc sulfate the zinc ions, and probably to a lesser extent the sulfate ions, will be combined with varying numbers of water molecules, that is, probably some ions will be anhydrous, some will have one water molecule attached, etc. As the concentration of the solution is increased, some of the zinc ions will hold to sulfate ions forming hydrated as well as non-hydrated zinc sulfate molecules. The non-hydrated molecule of zinc sulfate by reason of the large doublet it contains will tend to become hydrated. There will therefore be in the solution molecules of different degrees of hydration which will in turn tend to acquire more water molecules and also to associate together. When concentration has progressed far enough, this associating tendency will outweigh the reverse action. That particular hydrate will continue to grow which offers the greatest condensation of the forces involved. This will be usually the highest hydrate within which the forces are great enough to overcome the disrupting effect of thermal agitation.

Complex ions.—Complex ions result from the interaction between the fields of a neutral molecule and an ion. The ion becomes imbedded within the fields of the neutral part. A molecule, in order to form the neutral part of a complex ion, must have the following requisites:

1. It must have fields strong enough to hold the ion.
2. The attractions within the molecule must be such that it is not dissociated into ions either as a solid or upon solution.

Such molecules are furnished by compounds of a type intermediate between the molecule-forming and the polar classes, where the electron is held so strongly by the electropositive element that it can pass only part of the way over to the negative atom. The complex formed by the addition of potassium cyanide

to silver cyanide is typical. Silver cyanide possesses a structure similar to silver iodide. The cyanide ion is less strongly negative than the iodide ion, the electron is nearer the silver atom and consequently the doublet is of less moment. The fields within the silver cyanide molecule are quite intense. When the solid is placed in a solution of potassium cyanide, the cyanide ions will become by collision imbedded within these drawn-in fields between the silver atom and the cyanide radical. This additional cyanide ion will so increase the resulting doublet fields that the water molecules are able to cause solution by reason of the interaction of their fields with those of the new silver cyanide anion in the solid.

In future papers it is planned to discuss in detail the information which X-ray determinations of the structure of crystals, infra-red spectra measurements, and specific heat measurements offer concerning the nature of the forces between the atoms in solids, and to present the results of X-ray studies of various typical crystals.

SUMMARY

1. The structure of the atom, as we now know it, is discussed with reference to the nature of the forces operating between atoms, and it is emphasized that only the arrangement of the outside electrons has a bearing on the phenomena usually included under the term "chemistry." The arrangement of the inner electrons cannot be deduced from chemical data alone. The outstanding fact is the tendency, still unexplained, to form "closed clusters" of eight or twice-eight electrons.

2. Several typical compounds are considered with reference to the nature of the forces producing them. All compounds lie between the two extremes of "polar" and "non-polar" compounds. A simplified method of representing the type of combination in a given compound is suggested.

3. Solid substances are classified, according to the nature of the forces of combination, into molecule-forming, polar, and valency compounds.

4. The phenomena of adsorption, solubility, ionization in solution, formation of complex ions, and molecular complexes are discussed from this point of view.

ANTHROPOLOGY.—*Some general notes on the Fox Indians.*[1] Part III: *Bibliography*. TRUMAN MICHELSON, Bureau of American Ethnology.

LINGUISTICS.[2]

BOAS, FRANZ. *The Indian languages of Canada.* Annual Archaeological Report 1905: 88–106. Toronto. 1906.
The description of Algonquin (94, 95) is based essentially on Jones' first paper.

FLOM, GEORGE T. *Syllabus of vowel and consonantal sounds, in Meskwaki Indian.* 1906. Published by the State Historical Society of Iowa.
Known to me only by the remarks on p. vi of *A collection of Meskwaki Manuscripts* and in the list of names of Meskwaki Indians in the *Iowa Journal of History and Politics*, April, 1906. The title may therefore not be absolutely accurate. To judge from the orthography of the Indian names, the phonetic scheme is deficient. Apparently the author was unacquainted with the work of William Jones.

JONES, WILLIAM. *Some principles of Algonquian word-formation.* Amer. Anthrop. n. ser. 6: 369–411. 1904.
The first scientific paper on the Fox language.

JONES, WILLIAM. *An Algonquin syllabary.* Boas Anniversary Volume: 88–93. 1906.
Explains the principles of a number of Fox syllabaries. Only the first one described is in current use. At least two others not described by Jones exist; however, their mechanism is on the same lines.

JONES, WILLIAM. *Fox texts.* Publ. Amer. Ethnol. Soc. 1: 1907.
Gives a description of Fox phonetics as he conceives them, and numerous texts.

JONES, WILLIAM. *Algonquian (Fox)* (revised by Truman Michelson). Handbook American Indian Languages. Bur. Amer. Ethnol. Bull. 40, Part 1: 735–873. 1911.

MICHELSON, TRUMAN. *On the future of the independent mode in Fox.* Amer. Anthrop. n. ser. 13: 171, 172. 1911.

MICHELSON, TRUMAN. *Preliminary report on the linguistic classification of Algonquian Tribes.* Bur. Amer. Ethnol. Ann. Rep. 28: 221–290b. 1912.

MICHELSON, TRUMAN. *Note on the Fox negative particle of the conjunctive mode in Fox.* Amer. Anthrop. n. ser. 15: 364. 1913.

MICHELSON, TRUMAN. *Contributions to Algonquian grammar.* Amer. Anthrop. n. ser. 15: 470–476. 1913.

MICHELSON, TRUMAN. *Algonquian linguistic miscellany.* Journ. Wash. Acad. Sci. 4: 402–409. 1914.

MICHELSON, TRUMAN. *The so-called stems of Algonquian verbal complexes.* XIX Internat. Cong. Americanists: 541–544. 1917.

MICHELSON, TRUMAN. *Notes on Algonquian languages.* Intern. Journ. Amer. Lang. 1: 50–57. 1917.

MICHELSON, TRUMAN. *Two proto-Algonquian phonetic shifts.* Journ. Wash. Acad. Sci. 9: 333–334. 1919.

MICHELSON, TRUMAN. *Some general notes on the Fox Indians.* Part II: *Phonetics, folklore and mythology.* Journ. Wash. Acad. Sci. 9: 521–528. 1919.
See 521–525. There are some unfortunate misprints, which are corrected in an errata sheet preceding the index.

WARD, DUREN J. H. *The Meskwaki people of to-day.* Iowa Journ. Hist. Pol. 4: 190–219. 1906.
Gives the more current syllabary; also the phonetic elements of the Fox language as he conceives it. The priority of this paper or Jones' second one is unknown. The phonetic scheme is better regarding vowels than consonants. It is deficient in important respects. The philosophic tendencies are those of Gobineau, on which see Boas, *Mind of Primitive Man*, Chap. V (1911) and Michelson, Journ. Wash. Acad. Sci. 7: 234. 1917.

[1] Published with the permission of the Secretary of the Smithsonian Institution.

[2] The vocabularies, etc., contained in the works of early writers, such as Marston, Forsyth, Galland, Fulton, and Busby, are passed over, for the words are so badly recorded as to be utterly useless.

WELD, LAENAS G.; RICH, JOSEPH W.; FLOM, GEORGE T. *Prefatory note.* Coll. Meskwaki Manuscripts, Publ. State Hist. Soc. Iowa. 1907: v–vii.
Remarks on the alphabet employed by Cha kă ta ko si (ordinarily known as "Chuck") in volume; various remarks on the phonetic elements of Fox. Not of much value. The fact that j is used for the ch sound does not point to French influence as is stated: j in French has the value of z in azure; while j in the "Manuscripts" certainly for the most part has the phonetic value of dtc. It is more likely that the j is a reflection of English j, heard in a slightly faulty manner. The alphabet is certainly not in common use among the Foxes; and I suspect Chuck invented it The Indian texts contained in the volume can be used by the specialist.

FOLKLORE AND MYTHOLOGY

BLAIR, EMMA HELEN. *Indian Tribes of the Upper Missisipi Valley and the Great Lakes Region.* 2: 142–145. 1912.
The volume contains Marston's letter to Rev. Dr. Jediah Morse, dated November, 1820; originally printed in the latter's report to the Secretary of War, dated November, 1821, printed at New Haven, 1822. The supposed historic statement that the Shawnees were descended from the Sauk nation by a (Sauk or Fox?) chief, is nothing more than a (Sauk or Fox?) variant of the "Bear-foot Sulkers," on which see Jones, *Fox Texts:* 30, 31. To-day the Shawnee tell it of the Kickapoo and *vice versa* (Michelson, information).

BUSBY, ALLIE B. *Two summers among the Musquakies.* 1886.
Contains extract from Isaac Galland's *Chronicles*, etc. See below.

FULTON, A. R. [Initials stand for?] *The Red Men of Iowa.* 1882.
Contains extract from Isaac Galland's *Chronicles*, etc. See below.

GALLAND, ISAAC. *Chronicles of Northamerican savages.* 1835.
Complete copies are apparently impossible to obtain. Has important information on the gentes and tribal dual division. Part of this cannot be substantiated to-day. Portions reprinted in *Annals of Iowa*, 1869, under the title of *Indian Tribes of the West* (especially 347–366), also in Fulton's *The Red Men of Iowa*, 1882 (131–134), also in Busby's *Two summers among the Musquakies*, 1886 (52–63).

JONES, WILLIAM. *Episodes in the culture-hero myth of the Sauks and Foxes.* Journ. Amer. Folk-Lore 15: 225–239. 1901.

JONES, WILLIAM. *Fox texts.* 1907.
Most important of all publications on the subject.

JONES, WILLIAM. *Notes on the Fox Indians.* Journ. Amer. Folk-Lore 24: 209–237. 1911.
Contains much matter supplementary to his *Fox Texts.*

MARSH, CUTTING. Letter to Rev. David Greene, dated March 25, 1835. Printed in *Wisc. Hist. Coll.* 15: 104–155. 1900.
Traditions regarding the Me-shaum (phonetically mī'cām^{mi}'), We-sah-kah (Wī'sA'ka'A', the culture-hero), the death of his brother, the flood, etc. See pp. 130–134. Most of the information given can be substantiated to-day. The parts of the letter appurtenant to Fox ethnology, folklore and mythology have been reprinted in the appendix to M. R. Harrington's *Sacred bundles of the Sac and Fox Indians* (1914).

MARSTON, MAJOR M. Letter to Rev. Dr. Morse. 1820. Printed in Morse's *Report to the Secretary of War*, 1822.
See p. 122 for a supposed historic statement which is nothing more than legendary: *vide supra* under Blair.

MICHELSON, TRUMAN. *Notes on the folklore and mythology of the Fox Indians.* Amer. Anthrop., n. ser. 15: 699, 700. 1913.
Points out that Fox folklore and mythology consists of native woodland and plains as well as European elements.

MICHELSON, TRUMAN. *Ritualistic origin myths of the Fox Indians.* Journ. Wash. Acad. Sci. 6: 209–211. 1916.

MICHELSON, TRUMAN. *Some general notes on the Fox Indians.* Part II: *Phonetics, folklore and mythology.* Journ. Wash. Acad. Sci. 9: 521–528. 1919.
General discussion of Fox folklore and mythology.

OWEN, MARY ALICIA. *Folklore of the Musquakie Indians of North America.* 1904.
See the review by Michelson in *Curr. Anthrop. Lit.* 2: 233–237. 1913.

STEWARD, JOHN FLETCHER. *Lost Maramech and earliest Chicago.* 1903.
A number of stories are scattered throughout the text. 57–59: Bull Head and Elk; Wa-sa-ri misprint for Wa-sa-si, or a corruption of some sort; phonetically wā'se'sī'A'. Michelson has a variant of this in his unpublished collection. 59–62: Wi-sa-ka and the Dancing Ducks; variant to Jones' *Fox Texts*, 278–289; a Sauk version collected by Michelson agrees in part quite closely with tale collected by Steward. 62–65: They who went in pursuit of the Bear; variant to Jones' *Fox Texts*, 70–75. 345–351: Wa-pa-sai-ya; variant to Jones' *Fox Texts*, 8–31, and his *Notes on the Fox Indians*, 231–233; two unpublished versions collected by Michelson agree more closely with those of Jones than with that of Steward.

ETHNOLOGY

ARMSTRONG, PERRY A. *The Sauks and the Black Hawk War.* 1887.
Quite a bit of Sauk ethnology may be gleaned from this. Marred by the statement (13) that with the "Sauks, like all other Indian nations, the gens ran in the female line"—which is an absurdity, and is not only opposed to the information given by the Sauk Indians of to-day, but is in direct contradiction to the testimony of Morgan (1877) and Forsyth (1827; see Blair, *infra*). Evidently the author was under the influence of Morgan's general theories as was McGee (*Amer. Anthrop.* 1898: 89).

ATWATER, CALEB. *The Indians of the northwest.* 1850.
See especially pp. 72, 76, 81, 87, 93, 104, 105, 106, 107, 115, 123, 129, 130, 132, 175. The time referred to is 1829.

BELTRAMI, GIUCOMO C. *A pilgrimage,* etc. 1828.
See his letter dated May 24, 1823, in vol. 2.

BLAIR, EMMA HELEN. *The Indian tribes of the Upper Missisipi Valley and the Great Lakes Region.* 1912.
Vol. 2 contains Major Marston's letter to Jediah Morse, dated November, 1820, originally printed in the latter's report to the Secretary of War, dated 1821, printed 1822; and Thomas Forsyth's "Account of the Manners and Customs of the Sauk and Fox nations of Indian Traditions," a report to General Clark dated St. Louis, January 15, 1827. These two are the best accounts of Fox ethnology. Forsyth's "Account" is printed here for the first time.

BUSBY, ALLIE B. *Two summers among the Musquakies.* 1886.
Besides containing extract from Galland (see *infra*), also gives lists of gentes, dances, marriage ceremonies, description of some ceremonials, burial customs; clothing, etc. These are the observations of a former school-teacher, and are interspersed with more or less interesting gossip. The ethnological observations for the most part can be substantiated; on some matters (*e. g.*, the "Mule Dance") the author is hopelessly in the dark as to the real import.

CARVER, JONATHAN. *Three years travel,* etc. 1796.
Though published in 1796, refers to thirty years previously, in round numbers. See 30, 31, 145, 170, 219, 230.

CATLIN, GEORGE. *Illustrations of the manners, customs, and condition of the North American Indians.* 1841.
See vol. 2: 207–217. There are other editions. Important. Good for certain dances, clothing, and ethnological facts.

FULTON, A. R. *The Red Men of Iowa.* 1882.
See Chapters VIII and XXIII especially. Contains an extract from Galland, historical and ethnological notes. Needless to say, the translation of Mus-qua-kie "the man with the yellow badge or emblem" and of Sau-kie "the man with the red badge or emblem" should be reversed, and even then the renditions are not accurate; Mus-qua-kie means "Red-Earths;" and Sau-kie is often taken (though mistakenly) to mean "Yellow-Earth." [The last really means "They who came forth." Once given "Red-Earths," "Yellow-Earths" would be a popular etymology, though not correct—witness medial -g-, not -'k-, in the native designation.]

GALLAND, ISAAC. *Chronicles of the Northamerican savages.* 1835.
Contains an account of the gentes, but it is not certain whether the list is for the Sauks or Foxes. The dual division is based on some misunderstanding. Complete copies are apparently not now to be had. Portions reprinted in *Annals of Iowa*, **1869**: 194 et seq.; see especially 347–366; also in the popular books of Busby and Fulton.

HARRINGTON, M. R. *Sacred bundles of the Sac and Fox Indians.*
University Museum Anthrop. Publ. 4, no. 2, 1914. See review by Michelson, *Am. Anthrop., n. ser.*, **17**: 576-577, by Skinner, *ibidem*, 577–579. Gives a sketch of Sac and Fox culture; detailed description of sacred packs; exquisite photogravures. Besides the references to sacred packs given by Michelson, loc. cit., the following are in order: Armstrong: 37; Beltrami, **2**: 159; Keating (see *infra*), **2**: 229; *Rep. Comm. Ind. Affairs*, **1851**: 66. As long as Skinner gives a reference to a presumably Ottawa pack, attention may be called to *Ann. Prop. Foi*, **4**: 481. The Potawatomi term for sacred pack is the phonetic correspondent to the Ottawa pindikossan of Perrot [Michelson], as is evidently the Ojibwa pindjigossan (taken from Baraga); Cree kaskipitâgan (from Lacombe) stands by itself; Sauk, Kickapoo, Shawnee all have phonetic equivalents to Fox mī'cāmmi' (Michelson, information).

HODGE, FREDERICK WEBB. *Handbook of American Indians.* 1907, 1910. Bur. Amer. Ethnol. Bull. 30.
See articles Fox, Sauk. Full bibliographies at end.

JONES, WILLIAM. *The Algonkin Manitou.* Journ. Amer. Folk-Lore 18: 183–190. 1905.
Best exposition of the fundamentals of Fox religion.

JONES, WILLIAM. *Fox texts.* 1907.
Contains incidental ethnological notes.

JONES, WILLIAM. *Mortuary observances and the adoption rites of the Algonquin Foxes of Iowa.* Congres International des Americanists, XV[1]: 263–277. 1907.

JONES, WILLIAM. *Notes on the Fox Indians.* Journ. Amer. Folk-Lore 24: 209, et seq. 1911.
Various ethnological notes interspersed with folk tales. Rules governing membership in tribal dual division wrongly given.

KEATING, WILLIAM H. *Narrative of an expedition to the source of St. Peter's River—in the year 1823.* 1824.
See vol. 1. Though primarily concerned with Sauk ethnology, nevertheless should be consulted.

LAHONTAN, ARMAND L. DE. *New voyages to North America.* 1703.
See 2: 85.

LONG, JOHN. *Voyages and travels of an Indian interpreter and trader.* 1791.
See p. 151.

MCKENNEY and HALL. *History of the Indian tribes of North America.* 1854.
Especially good for Fox costumes; contains other valuable facts.

MARSH, CUTTING. Letter to Rev. David Greene, dated March 25, 1835. Printed in *Wisc. Hist. Coll.* 15: 1900.
Reprinted as far as concerns Fox ethnology, etc., in Harrington's *Sacred bundles.* Information on the whole, good.

MICHELSON, TRUMAN. *Notes on the social organization of the Fox Indians.* Amer. Anthrop. n. ser. 15: 691–693. 1913.
It is possible that the information given may have to be modified in some details, but not the rules given governing membership in the tribal dual division; and the general proposition that the dual division is for ceremonial as well as for athletic purposes stands.

MICHELSON, TRUMAN. *Terms of relationship and social organization.* Proc. Nat. Acad. Sci. 2: 297–300. 1916.
General discussion of terms of relationship; and Algonquian ones in particular. Discussion of the Fox system is incidental.

MORGAN, LEWIS H. *Systems of consanguinity,* etc. 1871.
The "Sauk and Fox" system is from Sauk informants; some schedules are faulty; the Sauk and the Fox systems are identical (Michelson, information).

MORGAN, LEWIS H. *Ancient society.* 1877.
Gives list of gentes, but whether Sauk or Fox is unknown. The two tribes, though legally consolidated, are distinct ethnologically and linguistically.

OWEN, MARY ALICIA. *Folk-lore of the Musquakie Indians of North America.* 1904.
The ethnological data are untrustworthy: see the review by Michelson, *Curr. Anthrop. Lit.* 2:233–237; that of "A. F. C. and I. C. C." in *Journ. Amer. Folk-Lore* 18: 144–146 is a bare enumeration of the contents of the volume without any attempt at criticism.

PATTERSON, J. B. *Autobiography of Black-Hawk.* 1882.
Has data on Sauk ethnology and so is of value.

PIKE, ZEBULON MONTGOMERY. *An expedition,* etc. (ed. Coues). 1895.
See 338, 339.

REPORTS OF THE COMMISSIONER OF INDIAN AFFAIRS.
For facts beyond population and statistics see reps. for 1851: 66; 1896: 162; 1897: 148; 1898: 161, 166, 171; 1901: 240. As a whole reliable.

INSTITUTIONS AT WHICH THERE ARE FOX ETHNOLOGICAL COLLECTIONS

American Museum of Natural History. Collector: WILLIAM JONES.

Cambridge University Museum of Archeology and Ethnology. Collector: MISS OWEN.

Davenport Academy of Sciences. Collector: TRUMAN MICHELSON.

Field Museum of Natural History. Collectors: WILLIAM JONES, TRUMAN MICHELSON, and one or two others.

Museum für Völkerkunde (Berlin). Collector: TRUMAN MICHELSON.
One sacred pack.

Museum of the American Indian. Collectors, M. R. HARRINGTON, TRUMAN MICHELSON

United States National Museum. Collector: TRUMAN MICHELSON.
Sacred packs only.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue.

GEODESY.—*Grid system for progressive maps in the United States.* WILLIAM BOWIE and OSCAR S. ADAMS. U. S. Coast and Geodetic Survey. Special Publ. 59. Pp. 227, figs. 6. 1919.

This publication contains tables, with the description of their use, which make it possible to construct a "grid" on any map in the United States, similar to the grids used on military maps in Europe during the war. The basis for the grid system in the United States is the polyconic projection. The polyconic projection lines cannot be used to advantage in military operations where it is necessary to compute quickly the distance and direction between two points, but by means of a plane coordinate system, the relation between any two or more points can be obtained easily by the solution of right-angled triangles. The values in the tables in this publication are the plane coordinates for the intersections of 5-minute parallels and meridians. The country is divided into seven zones and any coordinate can be used for each of the seven zones by merely shifting the longitude by 8°. It was impracticable to have a single zone for the whole country, because of its wide extension in longitude. The zones in the United States extend in a north and south direction and are 9° in width. Each zone overlaps the contiguous zones by 1°. This makes it possible to avoid a complete break in the plane coordinates at the margins of the zones. The grid lines of two zones can be used on the maps in the overlapping areas and thus provide a connection between them.

The origin for each zone is outside of the United States and is to the southwest of each zone. By having the origin in this location all of the coordinates within the zone are positive. The X-coordinates increase to the eastward and the Y-coordinates to the northward.

A careful study was made of the various projections in general use

before deciding on the one to be used as the basis for the grid tables. The Lambert projection, which was used in France, was not applicable to the United States because of the great range in latitude in this country.

The publication contains examples of the transformation of the geographic to grid coordinates and the reverse. While the tables were computed especially for use in the construction of military maps in the United States, it is possible that the system may sometime be used on maps for civil purposes. W. B.

PHYSICS.—*Specific heat determination at higher temperatures.* WALTER P. WHITE. Amer. Journ. Sci. 47: 44–59. January, 1919.

This paper deals with the experimental technic of specific heat determination at temperatures up to 1400° by the "method of mixtures," and continues some earlier presentations. Detailed modifications in furnaces and in methods of transferring to the calorimeter are described. The heat losses attending the dropping of hot bodies into water proved to be surprisingly large; their prevention is probably advisable in accurate work, perhaps by the use of aneroid calorimeters. W. P. W.

PHYSICS.—*The determination of the compressibility of solids at high pressures.* L. H. ADAMS, E. D. WILLIAMSON, and JOHN JOHNSTON. Journ. Amer. Chem. Soc. 41: 12–42. January, 1919.

This paper describes a method by means of which the volume-change under pressure of a solid may be determined with an accuracy of about one part in 10,000 of the original volume of the solid. Results are presented for the metals gold, copper, silver, aluminum, zinc, tin, cadmium, lead, and bismuth; for the alloys brass and tin-bismuth eutectic; and for sodium chloride, calcium carbonate, and silica, both crystalline and amorphous. The pressure range was 2,000 and 12,000 megabars (1 megabar = 0.987 atm.). The $P — \Delta V$ graphs which show the relation between volume-change and pressure were found to be nearly straight lines; however, the more compressible metals exhibit a slight but unmistakable curvature such that the graphs are concave toward the pressure axis. From this curvature a rough estimate was obtained of the change of compressibility between 0 and 10,000 megabars of all the solids examined (except gold, copper, silver, aluminum, and brass, for which the compressibility is independent of pressure within the error of experiment). L. H. A.

INORGANIC CHEMISTRY.—*The thermal dissociation of sulfur dioxide.* J. B. FERGUSON. Journ. Amer. Chem. Soc. **41**: 69–72. January, 1919.

The degree of dissociation and the equilibrium constants for the dissociation of sulfur dioxide have been calculated from the equilibrium measurements of the reduction of sulfur dioxide by carbon monoxide and the dissociation of carbon dioxide, and the results of these calculations for a number of temperatures and pressures are given in this paper. The values obtained confirm the experimental results which indicated that the dissociation was too slight to be directly studied by the present available methods. J. B. F.

ANALYTICAL CHEMISTRY.—*A contribution to the methods of glass analysis, with special reference to boric acid and the two oxides of arsenic.* E. T. ALLEN and E. G. ZIES. (Geophysical Lab. Papers on Optical Glass, No. 5.) Journ. Amer. Ceramic Soc. **1**: 739–786. Nov., 1918.

Arsenic. An accurate method for the separation and determination of both trivalent and pentavalent arsenic in glasses is described. The separation depends on the volatilization of the trivalent arsenic as AsF_3 when the glass is heated with hydrofluoric and sulfuric acids, while the pentavalent arsenic remains in the residue. The procedures described for arsenic in glasses are generally applicable to substances in which the arsenic can be transformed into sulfide without loss, and are highly accurate. A comparison of the iodometric method and the magnesium pyroarsenate method for arsenic in glasses is made. The former has the advantage in accuracy, and also in speed except where occasional determinations are called for.

Boric Acid. For the determination of boric acid we have found that Chapin's method is very reliable and yields highly accurate results. It has been shown that in order to obtain very accurate results a "blank" must be made and the value applied as a correction to the amount of boric acid found. The correction is small and for ordinary work can be neglected. The accuracy of the method is very appreciably affected by relatively large amounts of *arsenious* acid but not by *arsenic* acid. Relatively large amounts of fluorides appreciably affect the accuracy of the determination but do not seriously impair its usefulness for ordinary work.

Other Determinations. Experience with the following cases in glass

analysis is detailed: (1) The determination of the minute quantities of iron in *optical* glass; (2) the separation and determination of zinc; (3) the separation and determination of lead and barium occurring together; (4) the separation of calcium or barium from relatively large quantities of aluminum occurring with almost no iron; (5) the determination of those elements in boric acid glasses with which the boric acid interferes. Attention is called to the universal presence of hygroscopic moisture in powdered glass samples. Some data by E. S. Shepherd on gases in glass are given. E. T. A.

GEOLOGY.—*Salt resources of the United States.* W. C. PHALEN. U. S. Geol. Survey Bull. 669. Pp. 284, pls. 17, figs. 16. 1919.

This bulletin describes the geology of the salt deposits of the United States, discussing separately by States the position and extent of deposits, and the stratigraphy and structure of the region, and gives a bibliography for each State. It also gives theories of origin and formation of salt deposits; the chemical composition of saline materials; and statistics of the production of salt in the United States from 1880 to 1917. R. W. STONE.

GEOLOGY.—*Clays and shales of Minnesota.* FRANK F. GROUT. U. S. Geol. Survey Bull. 678. Pp. 251, pls. 16, figs. 38. 1919.

This bulletin comprises a discussion of the distribution, origin, properties, classification, and adaptability of the clays and shales of Minnesota. An attempt has been made to test all the more important deposits with sufficient exactness to determine for what purposes they may be used. The general character of each geologic formation and the character of the clay products made from it by the several methods of manufacture are set forth. Deposits suitable for common brick are abundant and widely distributed in many accessible localities in the eastern part of the State. The red laminated clay of the eastern counties makes good red brick and may be used as a slip glaze for semi-refractory ware. R. W. STONE.

GEOLOGY.—*The Anvik-Andreafski region, Alaska.* GEORGE L. HARRINGTON. U. S. Geol. Survey Bull. 683. Pp. 69, pls. 7. 1918.

The Anvik-Andreafski region as described in this report embraces the territory west and north of the lower Yukon River between Anvik and Andreafski rivers and an extensive area of low-lying country immediately contiguous to the Yukon on its east and south sides.

Greenstones of a rather wide range in composition and origin make up a large proportion of the metamorphic rocks. Closely associated with the greenstones are slates, quartzites, and conglomerates and many intermediate rock types. The greenstones appear to have suffered the most intense changes, but secondary structure has developed in the sediments also. Undeformed acidic dikes cut both the greenstones and the sediments. It is tentatively assumed that the greenstones, including the tuffs and some conglomerates which occur with them, are of late Paleozoic age and that the sedimentary rocks are the metamorphosed equivalents of the Cretaceous beds found elsewhere in this region.

Cretaceous rocks were found on Anvik and Andreafski rivers and probably occupy much of the intervening area. More or less closely associated with the Cretaceous rocks in the northern and eastern parts of the region are a series of tuffs and flows of intermediate basic types. Some of the flows appear to be intercalated with the Cretaceous sediments. In the southern part of the region are a number of dacitic porphyry dikes of late Cretaceous or post-Cretaceous age.

No sediments of known Tertiary age were found in the area, but at somewhat widely separated points vesicular lavas occur as undeformed horizontal flows which are either late Tertiary or early Quaternary. Quaternary deposits are found throughout the region.

At the beginning of the Quaternary period the surface stood at a somewhat higher elevation than now, and the base-level of erosion was lower, so that many of the streams were able to carve deeper valleys in bedrock than those they now occupy. It appears likely that the stream systems had become well established and a fairly mature topography had been developed. At some time in this stage of erosion there was an extravasation of basaltic lava which materially altered the courses of some of the larger streams, possibly including the Yukon itself or its predecessor.

The report concludes with a discussion of the mineral resources of the region. R. W. STONE.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

WASHINGTON ACADEMY OF SCIENCES

BOARD OF MANAGERS

At the meeting of the Board of Managers on April 30, 1919, the special committee on distribution of the *Proceedings* reported that 50 reserve sets had been wrapped, and arrangements had been made for the distribution of the greater part of the remaining complete sets.

At the meeting of the Board on May 26, 1919, the following committees were authorized and appointed: Committee to present to the Congressional commission on reclassification of government employees the desirability of enlisting the aid of the National Research Council: P. G. AGNEW and W. J. HUMPHREYS; committee to prepare information concerning scientific and technical positions in the government bureaus, for the assistance of the Reclassification Commission: F. L. RANSOME, F. V. COVILLE, E. B. ROSA, C. S. SCOFIELD, R. B. SOSMAN, W. T. SWINGLE.

At the meeting of the Board on June 30, 1919, the membership of the Academy in the American Metric Association was continued, and problems of reclassification, salaries, and retirement were discussed.

At the meeting of the Board on October 27, 1919, a committee consisting of PAUL BARTSCH, F. V. COVILLE, and F. L. RANSOME was requested to make a report concerning the relation of the Shaw Aquatic Gardens to the proposed engineering improvements along Anacostia River.

The following persons have become members of the ACADEMY since the last report in the JOURNAL:

Mr. OSCAR S. ADAMS, U. S. Coast and Geodetic Survey, Washington, D. C.

Dr. ARTHUR CHADEN BAKER, Bureau of Entomology, U. S. Department of Agriculture, Washington, D. C.

Mr. HERBERT SPENCER BARBER, National Museum, Washington, D. C.

Dr. CHARLES FRANKLIN BROOKS, U. S. Weather Bureau, Washington, D. C.

Mr. ALBERT FRANKLIN BURGESS, Bureau of Entomology, Melrose Highlands, Massachusetts.

Mr. OTIS FISHER BLACK, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

Mr. THEODORE CHAPIN, U. S. Geological Survey, Anchorage, Alaska.

Mr. ARTHUR J. ELLIS, U. S. Geological Survey, Washington, D. C.

Mr. HENRY C. FULLER, Institute of Industrial Research, Washington, D. C.

Mr. LOUIS J. GILLESPIE, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

Mr. R. B. HARVEY, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

Mr. OLIVER BAKER HOPKINS, U. S. Geological Survey, Washington, D. C.

Mr. JAMES A. HYSLOP, Bureau of Entomology, U. S. Department of Agriculture, Washington, D. C.

Mr. JAMES T. JARDINE, U. S. Forest Service, Washington, D. C.

Mr. NEIL M. JUDD, U. S. National Museum, Washington, D. C.

Dr. LYMAN FREDERIC KEBLER, Bureau of Chemistry, U. S. Department of Agriculture, Washington, D. C.

Dr. GEORGE RICHARD LYMAN, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

Mr. S. C. MASON, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

Dr. EVERETT FRANKLIN PHILLIPS, Bureau of Entomology, U. S. Department of Agriculture, Washington, D. C.

Mr. FRED J. PRITCHARD, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.

Mr. ARTHUR W. SAMPSON, U. S. Forest Service, Washington, D. C.

Mr. E. RALPH SASSCER, Bureau of Entomology, U. S. Department of Agriculture, Washington, D. C.

Mr. JOSHUA J. SKINNER, Bureau of Plant Indústry, U. S. Department of Agriculture, Washington, D. C.

ROBERT B. SOSMAN, *Corresponding Secretary.*

134TH MEETING

The 134th meeting of the ACADEMY was held jointly with the Chemical Society of Washington in the Assembly Hall of the Cosmos Club, the evening of Thursday, March 27, 1919. Dr. ARTHUR L. DAY, Director of the Geophysical Laboratory, Carnegie Institution of Washington, and Vice-President of the Corning Glass Works, Corning, New York, delivered an address on *Optical glass.* The lecturer outlined the position of the United States with respect to supplies of optical glass both in 1914, when imports from Europe began to be interrupted, and in 1917, when the United States entered the war. The danger from American dependence on European supplies had been recognized before 1917 and some progress had been made in this country in the manufacture of optical glass; but the situation was unsatisfactory, because the prospect that the supply would increase with sufficient rapidity to keep pace with the demands of the American Army seemed remote. Intensive efforts to stimulate the production of the one plant that was then producing glass in appreciable quantity, and the bringing into production of two additional commercial plants in the latter part of 1917, had by November, 1918, solved the problem of an adequate supply. At the same time laboratory and plant research had secured improved raw materials and had gotten at the many diffi-

culties with manufacturing processes, so that the quality also had been brought up to a high standard. The lecturer showed lantern slides illustrating the various processes used in manufacturing optical glass, together with curves indicating the rapid increase in American production in 1917 and 1918.

135TH MEETING

The 135th meeting of the ACADEMY was held in the Assembly Hall of the Cosmos Club, the evening of Friday, April 4, 1919, the occasion being an address by Lieut. Col. BYRON C. GOSS, U. S. A., Chief Gas Officer, Second Army, A. E. F., entitled *Gas warfare at the front*. The lecture was devoted principally to the military features of gas offense and defense, as experienced by the American Army in 1918. At this stage of the war reliance was placed mainly on gas shell, and the gas cloud, which was the method by which gas warfare was introduced in 1915, was very little used. The use of toxic shell may be divided into three periods. From May, 1915 to July, 1916 only lachrymatory shell were used. Phosgene and chlorpicrin shell, intended to produce casualties, came into increased use from July, 1916 to July, 1917. With the latter date began the use of the so-called "mustard gas." The tactical handling of gas shell depends on the object to be accomplished, whether the production of casualties or the neutralization of troops. Details of tactics and of shell design were ably discussed by the lecturer and were illustrated with lantern slides. The lecture closed with the presentation of some new moving pictures showing the use of thermit bombs and smoke clouds and the handling of gas shell by American artillery at the front in the autumn of 1918.

136TH MEETING

The 136th meeting of the ACADEMY was held in the Assembly Hall of the Cosmos Club, the evening of Thursday, May 15, 1919. An address was delivered by Prof. JOHN C. MERRIAM, Acting Chairman of the National Research Council, entitled *Cave hunting in California*. The discovery of prehistoric stone implements supposed to be from the auriferous gravels of California aroused interest some years ago in the question whether man was present on the West Coast during Pliocene or Pleistocene time. The lecturer outlined his early studies of the problem through the examination of auriferous gravels, river terrace gravels, and caves, illustrating the story with many lantern slides of California caves. Among the localities where significant material was obtained were Mercer's Cave in Calaveras County, Hawver's Cave and the Robbers' Cave in the American River valley, and Potter Creek Cave and Samwel Cave on the McCloud River. Many new species of extinct Pleistocene animals were found in the course of the explorations, but no absolutely certain evidence has been discovered of the existence of man in California before the present epoch. The lecture was discussed by several members of the Academy.

WILLIAM R. MAXON, *Recording Secretary*.

SCIENTIFIC NOTES AND NEWS

ANNOUNCEMENTS OF MEETINGS OF NATIONAL SCIENTIFIC AND ENGINEERING SOCIETIES

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE. St. Louis, Missouri, December 29–31, 1919. Chicago, Illinois, December, 1920.

NATIONAL ACADEMY OF SCIENCES. Washington, D. C., April, 1920.

AMERICAN CERAMIC SOCIETY. Hotel Walton, Philadelphia, Pennsylvania, February 23–26, 1920.

AMERICAN CHEMICAL SOCIETY. St. Louis, Missouri, April 13–16, 1920. Chicago, Illinois, September, 1920.

AMERICAN PHYSICAL SOCIETY. Chicago, Illinois, November 28–29, 1919.

GEOLOGICAL SOCIETY OF AMERICA. Boston, Massachusetts, December 29–31, 1919.

AMERICAN SOCIETY OF ZOOLOGISTS. St. Louis, Missouri, December 29 31, 1919.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. New York City, February 18–20, 1920. Annual Convention, June 22–25, 1920; place not yet decided upon.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS. New York City, December 2–5, 1919. St. Louis, Missouri, probably May, 1920.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS. New York City, February 16–20, 1920.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Pasadena, California, May 18, 1920.

THE MAP-MAKING CONFERENCE

On July 1, 1919, the Engineering Council addressed a letter to the President of the United States suggesting that a conference of the map-making bureaus of the Federal government be called in order to make plans for cooperation and for expediting the completion of the topographic map of the United States. On August 27 the President referred the matter to the Secretary of War and requested that a conference be called.

The conference was held on September 15–29, and the following fourteen map-making organizations of the Federal government were represented: U. S. Coast and Geodetic Survey, U. S. Geological Survey, General Land Office, Topographic Branch of the Post-Office Department, Bureau of Soils, U. S. Reclamation Service, Bureau of Public Roads, Bureau of Indian Affairs, International (Canadian) Boundary Commission, Forest Service, U. S. Hydrographic Office, and the following organizations from the U. S. Army: Corps of Engineers, Mississippi River Commission, and U. S. Lake Survey. Ten national scientific and engineering societies were also represented.

The conference reached the general conclusion "that there is little actual duplication of effort materially affecting the progress of mapping the United States. The U. S. Geological Survey is charged with the preparation of a topographic map of the United States, which, with certain minor modifications, will adequately meet the needs for a general utility map. The work of that bureau is progressing as rapidly as the available funds will permit. Approximately one-third of the area of the continental United States, exclusive of Alaska, is now covered by satisfactory maps of this class. The U. S. Coast and Geodetic Survey, in addition to its other work, is engaged in the execution of the primary control in the interior of our country. A basic horizontal and vertical control which will permanently establish some geographic position and elevation within about 50 miles of any point in the United States has been approximately 50 per cent completed. Close cooperation exists between the U. S. Coast and Geodetic Survey and the U. S. Geological Survey so that there is no duplication in carrying out the work necessary for the standard topographic map."

The report also shows that certain map needs of various other bureaus are met by the standard topographic map of the Geological Survey. In addition, they all require certain special maps, some of which demand more detailed surveys than those necessary for the standard map, and others of which require the collection of entirely different kinds of data. Some of the organizations concerned (for instance, the International Boundary Commission) are conducting specialized surveys, and while they would be benefited in some degree by the early completion of the standard map in the areas in which they operate, still this map would not obviate the need of the special surveys. The work of the Hydrographic Office is entirely outside the continental limits of the United States.

The conference adopted the following recommendation: "It is recommended that the present procedure be continued, under which the U. S. Coast and Geodetic Survey executes the primary control of the area of the United States and U. S. Geological Survey prepares, publishes, and distributes the standard topographic map and that Congress be asked to make larger appropriations for these purposes in order that the complete map may be available at an early date. * * * * * It is further recommended that this general project be approved and placed before Congress with the request that Congress adopt the project for execution by successive annual appropriations for these two bureaus. Under this general plan it is assumed that a large number of States will continue to cooperate in topographic mapping by making specific appropriations for that work."

The conference also recommended: (1) that a permanent Board of Surveys and Maps be appointed to act as an advisory body; (2) that a central information office be established, preferably in the U. S. Geological Survey, but under the general supervision of the Board of Surveys and Maps; (3) that the copyright laws be so amended as to provide that a copy of every map presented for copyright be trans-

mitted to the information office; (4) that all Government agencies be instructed to comply with requests for data from the Board; (5) that surveys by agencies other than the Geological Survey be made to conform to the specifications of the standard topographic map; (6) that the Coast and Geodetic Survey be given general supervision of the final adjustment of all important control data; (7) that maps be issued as soon as possible after the field work has been completed; and (8) that the program of the Interdepartmental Committee on Aerial Surveying be approved.

It is estimated that the work of primary control can be completed by 1933 at a cost of $6,305,000, and that the topographic map can be completed within the same period for $40,490,000 (including cooperative appropriations by States).

NOTES

Mr. C. H. Birdseye has been appointed Chief Topographic Engineer of the U. S. Geological Survey, to succeed Mr. R. B. Marshall, who recently resigned as Chief Geographer. Mr. Birdseye was formerly chief of one of the divisions of topographic mapping and during the War served in France as Lieutenant Colonel of the Coast Artillery. Mr. Marshall will remain a member of the Survey, being enrolled as a topographic engineer on a per diem status, and will thus be available for occasional service.

Prof. M. A. Carleton has resigned his position as cerealist with the U. S. Department of Agriculture, and is now engaged in special field investigations for the U. S. Grain Corporation, with headquarters at 42 Broadway, New York City.

Dr. Henry A. Christian, Dean of the Harvard Medical School, came to Washington on November 1 as chairman of the Division of Medical Sciences of the National Research Council.

Mr. D. Dale Condit has resigned from the Geological Survey, and Mr. Ralph W. Howell is on a year's leave of absence, to accept positions as petroleum geologists with Pearson and Sons. They sailed for England about the middle of October.

Mr. R. W. Frey, formerly with the leather and paper laboratory of the Bureau of Chemistry, U. S. Department of Agriculture, has resigned to accept a position in the chemical department of John H. Heald & Co., Inc., manufacturers of tanning and dye-wood extracts at Lynchburg, Va.

Dr. Albert Mann has resigned from the Department of Agriculture to accept an appointment as Research Associate of the Carnegie Institution of Washington. The change was made so as to enable him to give his entire time to his work on the diatoms. He will have his office and laboratory at the National Museum.

Prof. A. A. MICHELSON, of the University of Chicago, who was until recently engaged in research for the Navy Department at the Bureau of Standards, has been appointed Research Associate at the Mount Wilson Observatory of the Carnegie Institution of Washington, for the year ending July, 1920.

Mr. BERT RUSSELL, first assistant examiner in the Patent Office, and secretary of the Patent Office Society, has resigned in order to devote his attention to chemico-legal work with the firm of Prindle, Wright & Small, of New York City.

Mr. C. E. SIEBENTHAL, geologist of the U. S. Geological Survey, will spend a large part of his time this winter in the Internal Revenue division of the Treasury Department assisting in the adjustment of the income-tax valuation of mining properties.

Prof. C. A. SKINNER, formerly head of the Physics Department at the University of Nebraska, has recently come to Washington as chief of the Division of Optics of the Bureau of Standards.

Dr. M. W. TRAVERS, formerly of the Indian Institute of Science, Bangalore, India, and connected during the war with the manufacture of chemical glass in England, visited Washington in October.

Dr. L. B. TUCKERMAN, formerly professor of Theoretical Physics at the University of Nebraska, has recently joined the Engineering Materials Division of the Bureau of Standards.

Dr. P. V. WELLS, of the Bureau of Standards, is on leave of absence and is spending a year in the laboratory of Prof. PERRIN in Paris.

// JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 9 DECEMBER 4, 1919 No. 20

PHYSICS.—*The relation between birefringence and stress in various types of glass.* L. H. ADAMS and E. D. WILLIAMSON, Geophysical Laboratory, Carnegie Institution of Washington.

When a rigid body is subjected to stress there are produced changes in refractive index which are related to the direction of stress and to the vibration directions of the entering light. Isotropic substances such as glass then become birefracting. It is evident that birefringence may serve as a measure of strain and, consequently, of stress; indeed this method is commonly used for the determination of internal stress in glass, and is of especial importance in the examination of optical glass, which for use in lenses and prisms must be well annealed.

While it is common practice to speak of strain in glass in terms of birefringence, little is known concerning the absolute magnitude of the stresses or strains involved,[1] and, as a part of the general problem of glass annealing, definite information concerning the relation of birefringence to stress was required. Accordingly in this paper we present the results of some measurements of the birefringence due to loading of nine kinds of optical glass. A brief review of the optical effect of stress is also given.

EXPERIMENTAL METHOD AND RESULTS

Blocks of each kind of glass measuring about 2 by 3 by 3 cm. were prepared. The faces were made as nearly plane parallel

[1] The only observations known to us are those by Pockels with reference to several glasses, some of which were flint glasses, while the others were unusual aluminoborates. See page 615 and 620.

as possible, two opposite faces being polished and the other four faces left with a finely ground surface. Each block was in turn subjected to compression in a Riehlé vertical testing machine, and a beam of light polarized by a nicol prism was passed through the block, the plane of polarization of the light being at 45° to the direction of pressure. The blocks of glass when loaded showed a certain amount of double refraction which

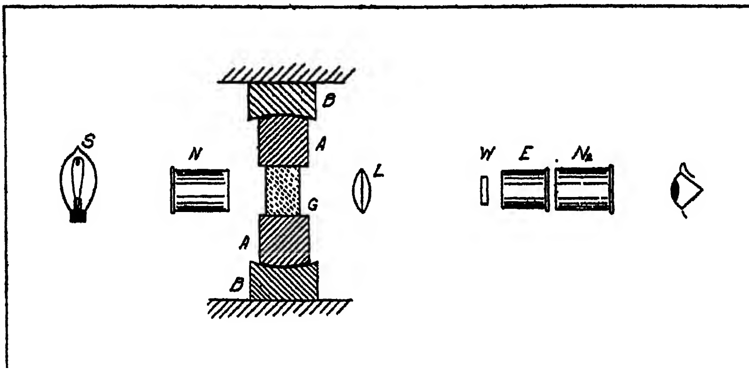


Fig. 1.

Diagrammatic representation of apparatus for measuring birefringence of glass under load. Pressure is transmitted to the block of glass *G* through the hardened steel blocks *A A* and *B B*. Light from the lamp *S* is polarized by the nicol prism *N*, passes through the glass, the lens L, the graduated quartz wedge *W*, the eyepiece *E* and the analyzing nicol N_2. The nicols are crossed and the axis of thrust makes an angle of 45° with the vibration direction of the light entering the block *G*.

could be detected by the use of polarized light, and could be measured by determining the optical path difference[2] according

[2] If two rays of light travel with velocities v_a and v_b through the distance l, we have $\frac{v_b}{v_a} = \frac{n_a}{n_b} = \frac{N_a}{N_b} = \frac{\lambda_b}{\lambda_a}$, n_a and n_b being the corresponding refractive indices, λ_a and λ_b the wave-lengths, and N_a and N_b the total numbers of waves. Moreover, $N_a = \frac{l}{\lambda_a} = \frac{n_a l}{\lambda_1}$ in which λ_1 is the wave-length corresponding to $n = 1$. Similarly $N_b = \frac{n_b l}{\lambda_1}$ and

$$N_a - N_b = \frac{(n_a - n_b)l}{\lambda_1}.$$

The product $n_a l$ or $n_b l$, respectively, is called the "optical path;" $(n_a - n_b)l$ is the "optical path-difference" and is the quantity which we measure. Obviously the birefringence $n_a - n_b$ may be obtained by dividing the optical path-difference by the geometrical length of path.

to standard methods.[3] The optical system for measuring the birefringence consisted of a petrographic microscope supported at the proper angle on one post of the testing machine and in such a position that the block of glass G was between the nicol N (Fig. 1) and the low-power lens L. A graduated quartz wedge, W, was in the focal plane of an eyepiece, E, on which was mounted a cap nicol, N_2.

Upon illuminating the system with light from an ordinary incandescent lamp, S, the wedge W—which was placed with its

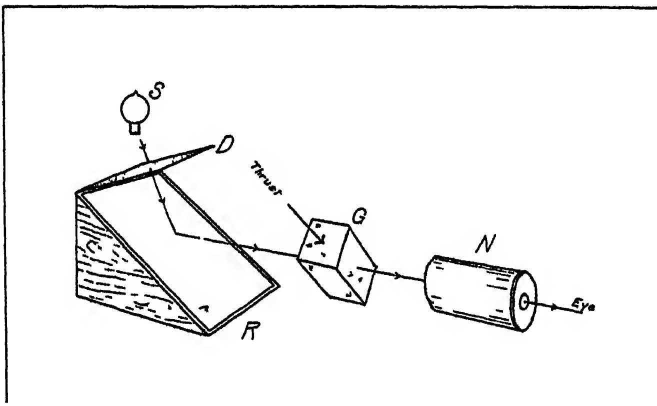


Fig. 2.

Diagram to show arrangement for determining the uniformity of loading. The block of glass G is illuminated by light from S which passes through the diffusing screen D and is reflected from the sheet of glass R. The thrust is applied to the glass in a direction at 45° to the plane of polarization of the light, and the interference colors produced by loading are observed through the analyzing nicol N.

longest dimension in a horizontal position—was observed through the eyepiece and nicol. When the analyzer was placed so that the nicols were crossed, a series of colored lines extended across the field in a vertical direction, and the position of the central black line with respect to the graduations on the wedge determined the birefringence of the specimen. One division on our wedge represented 10 $\mu\mu$ retardation and no difficulty was experienced in reading to $1/2$ division or 5 $\mu\mu$, which was about 1 percent of the maximum observed birefringence. The load

[3] For example, see F. E. Wright, *The methods of petrographic-microscopic research.* Carnegie Inst. Wash., Publ 158, Chap. III. 1911.

could be read to 0.1 kg. or better—a higher degree of precision than is necessary, since readings to within 5 kg. would correspond in accuracy to the readings of the wedge.

The first results obtained were irregular and generally unsatisfactory. This was found to be due to the fact that the load was not applied uniformly. In seeking to remedy this defect we found that the problem of loading a block of glass evenly up to a pressure of a few hundred kg. per sq. cm. offers unexpected experimental difficulties and requires the greatest possible amount of care and patience. Fortunately birefringence serves not only for the quantitative measurement of stress but also for the qualitative examination of the uniformity of stress.

TABLE 1

CHEMICAL COMPOSITION AND OPTICAL PROPERTIES OF THE VARIOUS GLASSES

Kind of glass	Refrac. index n_D	Recipr. rel. dispersion (constringence) ν	Approximate composition								
			PbO	CaO	BaO	ZnO	Na_2O	K_2O	Al_2O_3	B_2O_3	SiO_2
Ordinary Crown	1.523	59	—	12	—	—	14	1	—	—	73
Borosilicate Crown	1.516	62	—	—	4	—	9	8	—	12	67
Light Barium Crown	1.574	57	—	—	29	11	3	5	1	4	47
Heavy Barium Crown	1.608	57	—	—	43	8	—	—	3	6	40
Barium Flint	1.606	44	24	—	15	8	3	4	—	—	46
Light Flint	1.573	42	35	—	—	—	6	5	—	—	54
Medium Flint	1.616	37	48	—	—	—	3	4	—	—	45
Heavy Flint	1.655	33	52	—	—	—	3	3	—	—	42
Extra Heavy Flint	1.756	27	69	—	—	—	—	3	—	—	28

To detect unevenness of loading a polarizer of large aperture is required. A convenient arrangement is shown in Fig. 2. Light from the lamp *S* is diffused by the translucent screen *D* (of ground glass or tracing cloth) and polarized by reflection from the sheet of plate glass *R* which is painted black on the back. The vibration direction of the beam of light, as with the previous arrangement, is inclined 45° to the direction of pressure. The interference colors are observed through the nicol prism *N*, no lens being required. If the block of glass *G* be uniformly loaded it appears in the field of view to be of a certain uniform color

on the Newton scale, the color depending on the amount of birefringence present, but if the load be uneven the color will vary from place to place in bands or streaks or irregular blotches.

After numerous unsuccessful attempts to secure uniform stress throughout the blocks of glass, the following method was found to be satisfactory. The thrust was applied through two hardened steel blocks (*A*, *A* in Fig. 1) the curved surfaces of which were in contact with the curved surfaces of the blocks *B*, *B*. The adjacent surfaces of steel and glass were ground so as to be as nearly plane as possible and were then ground together with very fine emery. Above and below the block of glass was placed a piece of thin drawing paper. With this arrangement we were able to load the glass uniformly up to a pressure of 200 kg. per sq. cm., which was sufficient for the purpose.

TABLE 2

BIREFRINGENCE PRODUCED IN GLASS BY A THRUST OF 1 KG. PER SQ. CM.

Kind of glass	Path diff $\mu\mu$ per kg. D/W	Width of block cm b	$-b \times 10^{-7}$ D/W Birefringence due to 1 kg per sq cm	Modulus of compressibility Kg per sq. cm K	Modulus of rigidity. R
Ordinary Crown......	0.959	2.68	-2.57×10^{-7}	0.46×10^6	0.28×10^6
Borosilicate Crown....	0.852	2.35	-2.85×10^{-7}	0.43×10^6	0.29×10^6
Light Barium Crown..	0.964	2.92	-2.81×10^{-7}	0.52×10^6	0.30×10^6
Heavy Barium Crown.	0.638	3.37	-2.15×10^{-7}	0.53×10^6	0.29×10^6
Barium Flint.........	0.976	3.18	-3.10×10^{-7}	0.42×10^6	0.26×10^6
Light Flint...........	1.022	3.13	-3.20×10^{-7}	0.35×10^6	0.24×10^6
Medium Flint........	1.068	2.93	-3.13×10^{-7}	0.34×10^6	0.22×10^6
Heavy Flint.........	0.912	2.93	-2.67×10^{-7}	0.34×10^6	0.22×10^6
Extra Heavy Flint....	0.439	2.78	-1.22×10^{-7}	0.32×10^6	0.20×10^6

Table 1 shows the chemical composition and optical properties of the glasses used, and in table 2 are given the results of our measurements. If *W* is the load applied to the block of glass by the testing machine and *D* the corresponding optical path-difference as determined by the graduated quartz wedge, the ratio D/W was found to be constant for each specimen to within the limit of accuracy of the measurements. This result is in accord with the observation by Brewster[4] in 1814 that the

[4] BREWSTER, Phil. Trans. 1814, 1815, 1816.

optical effect produced is proportional to the amount of the stress.

The ratio D/W, however, is not independent of the dimensions of the block, but it is readily seen that W/ab is the pressure and that D/a is the path difference (b and a are the dimensions of the block measured transversely to the direction of thrust, a being in the direction of the beam of light (see Fig. 1)). Moreover, the ratio

$$\frac{D/a}{W/ab} \text{ or } \frac{bD}{W}$$

is the birefringence produced by unit pressure and is dependent only on the nature of the glass. It is interesting to note that only one dimension of the block needs to be measured. The second column of table 2 gives for each kind of glass the weighted mean value of D/W in $\mu\mu$ per kg., and in the third column are values of b, the width of the block in cm., *i. e.*, the length of an edge perpendicular both to the direction of thrust and the direction of the beam of light. The quantity bD/W as shown in the fourth column is then the birefringence produced by a pressure of 1 kg. per sq. cm. For reasons which will appear later it may be useful to know the rigidity and compressibility of each of the various kinds of glass. In the last two columns of table 2 are given the rigidity and compressibility calculated according to the method described by Hovestadt,[5] except for ordinary crown glass, the compressibility of which we measured by a method already described.[6] These calculated elastic constants are of course only approximate values, but are probably sufficiently accurate for our present purpose.

All of the results in the fourth column lie between 2.57×10^{-7} and 3.20×10^{-7} except for two comparatively uncommon glasses. It is a curious and unexpected circumstance that for the more generally used optical glasses a given stress should produce so nearly the same amount of birefringence. The heavy

[5] H. Hovestadt, *Jena glass.* Transl. by J. D. and A. Everett. London, 1902; pp. 155–160, 185–193.

[6] L. H. Adams, E. D. Williamson and J. Johnston. Journ. Amer. Chem. Soc. 41: 12–42. 1919.

barium crown, containing 43 per cent barium oxide (BaO), and to a still greater extent the extra heavy flint, containing 69 per cent lead oxide (PbO), show a much smaller ratio of birefringence to stress. The variation of this ratio with lead content in the flint glass has been investigated by Pockels,[7] who has expressed his results in a form very different from the one we have used. Before comparing his results with ours it is therefore necessary to give a short discussion of the principles involved.

THE ELEMENTARY THEORY OF OPTICAL EFFECTS PRODUCED BY STRESS

Since the stress at any point in a solid may be resolved into three components at right angles to each other, it is sufficient

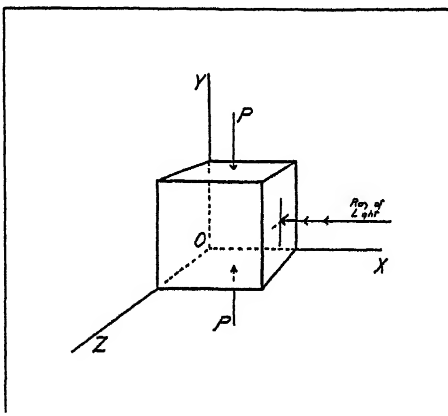


Fig. 3.

Drawing to accompany elementary discussion of optical effects of stress. The thrust P is applied in the direction OY. The ray of light enters the cube of glass in the direction OX, becomes elliptically polarized and is treated as two rays vibrating, respectively, in the directions OY and OZ. Ordinarily the ray vibrating along OY travels with the higher velocity, that is, ordinary glass under uni-directional compression behaves like an optically negative uniaxial crystal.

to consider what happens to light passing through a cube of glass subjected to forces normal to its faces. In Fig. 3 let OX, OY, OZ represent the coordinate axes, and consider a beam of light passing through the cube in a direction parallel to OX. Now if the glass be acted upon by a vertical thrust (*i. e.*, parallel to OY) the cube will be compressed in that direction and ex-

[7] F. Pockels. Ann. Phys. (4) 7: 745. 1902.

tended along OX and OZ. The velocity of the beam of light will be altered and in general the wave will be split into two wave fronts proceeding with different velocities and polarized in directions at right angles[8] to each other. Moreover, a ray of polarized light after passing through the block of glass in a direction normal to the surface will remain a single ray but will be found to be elliptically polarized and may best be treated as the resultant of two rays vibrating, respectively, along OY and OZ and differing in phase[9] by a certain amount. The compressed block of glass thus behaves as a uniaxial crystal whose optic axis is parallel to OY.

Now a thrust in the direction OZ will produce an effect similar to that in the direction OY, for the cube will be compressed in the direction OZ and extended along OY, but a thrust parallel to OX will produce no phase difference of the rays vibrating along OY and OZ since the cube is extended the same amount in these two directions.

It is evident, therefore, that when a beam of light passes through a block of strained glass the velocity of the light (and hence the refractive index of the glass) depends on (1) the direction of vibration of the light, and (2) the dilatations in those directions perpendicular to the path of the beam of light.

THE GENERALIZED EQUATIONS

The equations used by Neumann[10] for expressing the influence of elastic deformation on the propagation of light are as follows:

$$v_x = v + qx_x + py_y + pz_z \tag{1A}$$
$$v_y = v + px_x + qy_y + pz_z \tag{1B}$$
$$v_z = v + px_x + py_y + qz_z \tag{1C}$$

[8] A ray of light by reflection from a polished surface becomes partially or completely polarized. The plane of polarization is arbitrarily defined as the plane containing the incident and reflected rays, and the direction of vibration is usually taken as the normal to the plane of polarization. The vibration direction so defined is the direction of the electric vibrations of the electromagnetic disturbances and is perpendicular to the magnetic vibrations.

[9] In the actual measurement of birefringence the beam of polarized light is usually arranged to vibrate in a direction at 45° from OY or OZ. The phase difference obviously may be expressed as a path difference by taking account of the wave length of the light.

[10] F. NEUMANN. Ann. Phys. 54: 1841.

in which x_x, y_y, and z_z are dilatations in the three directions parallel to the three principal axes, v is the velocity of light in the unstressed material, and v_x, v_y, and v_z are the velocities of light waves whose vibrations are parallel to the three axes. p and q are coefficients which are to be determined by experiment.

If n is the refractive index of the unstressed medium and n_x, n_y, and n_z are the refractive indices for light vibrating in the three principal directions, then $nv = n_xv_x = n_yv_y = n_zv_z$ and from Equation (1_A)

$$\frac{v_x - v}{v} = \frac{n - n_x}{n_x} = \frac{q}{v}x_x + \frac{p}{v}(y_y + z_z). \tag{2}$$

Referring again to Fig. 3, it is obvious that a thrust, P, acting on the block in the direction OY will produce the three principal dilatations:

$$\begin{aligned} x_x &= \sigma P/E \\ y_y &= -P/E \\ z_z &= \sigma P/E \end{aligned}$$

E being Young's modulus and σ Poisson's ratio. Substituting in Equation (2) we have

$$\frac{n_x - n}{n_x} = \frac{P}{E}(1 - \sigma)\frac{p}{v} - \left(\frac{P\sigma}{E}\right)\frac{q}{v} = \frac{P}{E}\left[(1 - \sigma)\frac{p}{v} - \sigma\frac{q}{v}\right]. \tag{3A}$$

Similarly it can be shown that

$$\frac{n_y - n}{n_y} = \frac{P}{E}\left(-2\sigma\frac{p}{v} + \frac{q}{v}\right) \tag{3B}$$

and

$$\frac{n_z - n}{n_z} = \frac{P}{E}\left[(1 - \sigma)\frac{p}{v} - \sigma\frac{q}{v}\right]. \tag{3C}$$

When the coefficients p and q have once been determined, these three equations may be used for calculating the effect of a thrust, P, in the direction OY (Fig. 3) on the three indices of refraction n_x, n_y, and n_z corresponding to light vibrating in the directions OX, OY, and OZ. The changes in refractive index for a given thrust, P, depend on the elasticity constants E and σ, and the coefficients $\frac{p}{v}$ and $\frac{q}{v}$ which are characteristic of the given material and can be determined experimentally.

The change n_x is the same as that of n_z (for a thrust along OY) so that no birefringence is observed for a ray of light passing through the block in the direction OY, but the velocity of a ray in the direction of the triple arrow (*i. e.*, along OX) depends on the direction of vibration, that is, n_x is different from n_z and $n_y - n_z$, by definition, is the birefringence.[11]

Since ordinarily n_x and n_y do not differ from n by more than one part in 1000, we may put with a maximum error of a small fraction of one per cent

$$\frac{n_y - n}{n_y} - \frac{n_z - n}{n_z} = \frac{n_y - n_z}{n}$$

refore by subtracting Equations (3_B) and (3_C) we obtain

$$\frac{n_y - n_z}{n} = \frac{P}{E}(1 + \sigma)\left(\frac{q}{v} - \frac{p}{v}\right). \qquad (4)$$

This equation may be put in slightly different form by making use of the identity

$$R = \frac{E}{2(1 + \sigma)}$$

R being the modulus of rigidity. Substituting this value of R in Equation (4), we have

$$\frac{n_y - n_z}{n} = \frac{P}{2R}\left(\frac{q}{v} - \frac{p}{v}\right). \qquad (5)$$

From Equations (4) and (5) it is evident that the birefringence is proportional to the difference of the two coefficients p and q. Conversely, p and q can not be determined by measurements of birefringence alone, but if in addition to the birefringence we measure the absolute retardation of a ray of light vibrating, say, in the direction OY, both p and q will be uniquely determined.

Suppose now that instead of a thrust we apply to the block of glass a hydrostatic pressure, P'. In order to obtain a relation connecting the coefficients p and q with the *hydrostatic* pressure P', it is obvious from considerations of symmetry that

[11] In the case of a uniaxial crystal, birefringence is usually expressed as $n_\epsilon - n_\omega$, which is identical with $n_y - n_z$, the direction Y being the direction of the optic axis.

it is sufficient to add the three Equations, (3_A), (3_B), and (3_C). Then, since $\frac{n - n_1}{n_1}$ is approximately equal to $\frac{n - n_1}{n}$, we have

$$\frac{n_1 - n}{n} = \frac{P'}{E}(2 - 4\sigma)\frac{p}{v} + \frac{P'}{E}(1 - 2\sigma)\frac{q}{v} = \frac{P'}{E}(1 - 2\sigma)\left(\frac{2p}{v} + \frac{q}{v}\right) \quad (6)$$

By putting $\frac{E}{3(1 - 2\sigma)} = K$, in which K is the modulus of volume-elasticity,[12] the equation becomes

$$\frac{n_1 - n}{n} = \frac{P'}{3K}\left(\frac{2p}{v} + \frac{q}{v}\right) \quad (7)$$

which expresses in terms of known or measurable quantities the effect of hydrostatic pressure on the index of refraction, which of course under these conditions remains independent of the plane of polarization of the light.

COMPARISON WITH POCKEL'S RESULTS

The optical effects of stress on several kinds of glass have been studied by Pockels,[13] who loaded rectangular plates of the glasses and measured with a Jamin interferometer the absolute retardation of a ray of light vibrating parallel to the direction of pressure. He also measured the birefringence with a Babinet compensator and from the two series of measurements calculated the values of $\frac{p}{v}$ and $\frac{q}{v}$. His results are shown in table 3. The first column describes the glass, the second gives its number in Winkelmann's list;[14] in the third and fourth columns are the elastic constants of the glass; the index of refraction n is shown in the sixth column, and the percentage of lead oxide in the seventh. In the next two columns are the results of Pockels' determination of $\frac{p}{v}$ and $\frac{q}{v}$, the coefficients which occur

[12] $1/K = \beta$, the compressibility at constant temperature.

[13] F. Pockels. Ann. Phys (4) 7: 745 1902.

[14] Compare Hovestadt, *op. cit.*, p. 146.

in Equations (1) to (7) of this paper. Substituting these values in Equation (4) we have calculated the birefringence $n_y - n_z$ caused by a thrust of 1 kg. per sq. cm. and have placed the values obtained by this calculation in the last column of table 3.

We are now able to make a comparison between our results and those of Pockels. The first three glasses in table 3 are unusual alumino-borates, but the remaining four form a series of flint glasses with lead content varying over a wide range. In Fig. 4, for the sake of comparison, our results for the flint glass and also those of Pockels have been plotted with PbO content as abscissa and birefringence due to 1 kg. per sq. cm. as ordinate.

TABLE 3

RESULTS OF POCKELS' MEASUREMENTS ON OPTICAL EFFECTS OF STRESS

Kind of glass	Winkelmann's No.	E Young's modulus 10^6 kg. per sq. cm.	σ Poisson's ratio	n Refrac. index	Per-centage of PbO in glass	Coefficients of Equation (1) $\frac{p}{v}$	$\frac{q}{v}$	Birefringence due to 1 kg. per sq. cm. calc. from Equation (4)
Sodium Alumino-borate	2	0.480	0.274	1.508	—	0.274	0.166	—4.32
Lead Alumino-borate	42	0.472	0.268	1.512	32.	0.0908	0.0228	—2.76
Lead Alumino-borate	21	0.547	0.250	1.545	25.	0.289	0.182	—3.78
Light Flint	47	0.610	0.222	1.570	33.	0.306	0.213	—2.93
Heavy Flint	26	0.547	0.224	1.644	51.7	0.335	0.264	—2.61
Extra Heavy Flint	33	0.550	0.239	1.751	67.5	0.354	0.319	—1.38
Heaviest Flint	20	0.503	0.261	1.963	80.	0.427	0.466	1.92

By inspection of Fig. 4 it may be seen that Pockels' results for the flint glasses on the whole agree very well with ours. It should be noted, however, that the content of PbO does not completely determine the character of the glass and that therefore certain small discrepancies between Pockels' results and ours as indicated by Fig. 4 may not have a real existence.

It is interesting to note that ordinarily q is less than p. When this is the case the birefringence $n_y - n_z$ by Equation (5) is negative. But for the heaviest flint (PbO = 80 per cent) in-

vestigated by Pockels (see table 3) q is greater than p and therefore this glass when acted upon by a thrust shows positive double refraction.[15] Since the next flint glass in the series (PbO = 67.5 per cent) exhibits negative birefringence, it is evident that there must be some intermediate flint glass for which the birefringence would be zero and which therefore would remain isotropic under the influence of any elastic deformation. In attempting to make such a glass the composition 74.6 per cent PbO, 23.6 per cent SiO_2, 0.6 per cent ($K_2O + Na_2O$) was

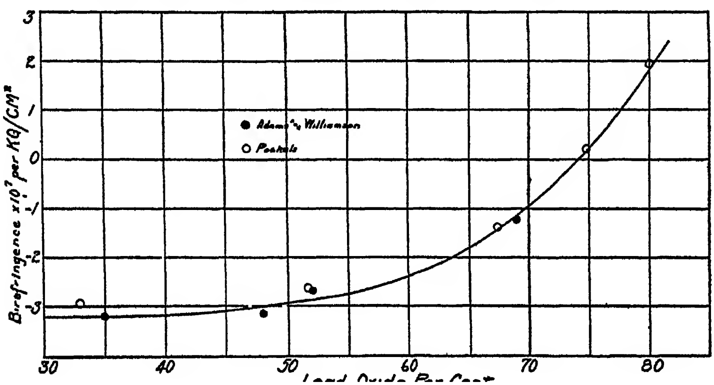


Fig. 4.

Graphical representation of the results for the *flint* glasses. The abscissa is % PbO and the ordinate is the birefringence caused by a *thrust* of 1 kg./cm².

tried by Pockels, and was found to give positive birefringence of 0.2×10^{-7}. This datum has also been plotted in Fig. 4, from which it can be seen that a glass containing about 74.0 per cent PbO would, no matter how poorly annealed, show no birefringence.

APPLICATION TO PROBLEMS DEALING WITH GLASS

As an example of the way in which the results given in this paper may be used, suppose that a sheet of ordinary crown glass be observed between crossed nicols and illuminated with white light, and suppose that in looking through 10 cm. of the sheet the interference color in a certain part of the cross-section is seen to be a red of the first order. In order to ascertain the

[15] It should be remembered that in Equations (3), (4) and (5), P is a thrust. If P be a tension most glasses will show positive double refraction.

internal stress corresponding to the observed color we find, by referring to a chart[16] showing Newton's color scale in terms of optical path-difference, that a first-order red corresponds to a retardation of about 530 $\mu\mu$ or 530×10^{-7} cm. The birefringence then is the path-difference per unit of length, that is, $\frac{530 \times 10^{-7}}{10} = 53 \times 10^{-7}$. Now, according to table 2, a birefringence of 2.57×10^{-7} corresponds in ordinary crown glass to a (uni-directional) pressure of 1 kg. per sq. cm. Hence the observed birefringence corresponds to a stress of $\frac{53 \times 10^{-7}}{2.57 \times 10^{-7}} =$ 20.6 kg. per sq. cm. or 300 lb. per sq. in.[17]

In conclusion, we shall note the change in refractive index produced (1) by a hydrostatic pressure of 1000 kg. per sq. cm. acting on a block of light flint glass; and (2) by a uni-directional pressure of 1000 kg. per sq. cm. According to table 3, $\frac{p}{v}$ and $\frac{q}{v}$ are, for light flint glass, respectively, 0.306 and 0.213; E is 0.61×10^6 kg. per sq. cm.; σ is 0.222; and n is 1.57. Substituting these values in Equation (6) we have

$$n_x - n = \Delta n = \frac{10^3(1-0.444)(0.612+0.213)1.57}{0.61 \times 10^6} = 0.00118.$$

The index of refraction is thus increased 0.0012 by a pressure (hydrostatic) of 1000 kg. per sq. cm., and this change in index is independent of the plane of polarization of the light. On the other hand, for the case of a uni-directional pressure, we use Equations (3_B) and (3_C), and suppose that, as in Fig. 3, the pressure is exerted along OY, and that the ray of light travels along OX. Then

$$n_y - n = \Delta n_\alpha =$$

$$\frac{1.57 \times 1000}{0.61 \times 10^6}(0.213 - 0.444 \times 0.306) = 0.00020$$

[16] See, for example, the chart in J. P. IDDINGS, *Rock Minerals* (1911); or N. H. WINCHELL, *Optical Mineralogy* (1909).

[17] We have observed, in poorly annealed glass, stresses very much higher than 300 lb. per sq. in. By taking into account the sign of path-difference in polarized light, it is easy to show that the stress in the center of a slab of unannealed glass consists of a tension in all directions parallel to the large surface of the slab.

and

$$n_s - n = \Delta n_\gamma = \frac{1.57 \times 1000}{0.61 \times 10^6}(0.306 \times 0.778 - 0.213 \times 0.222) = 0.00049.$$

That is, a thrust of 1000 kg. per sq. cm. changes the refractive index 0.00049 for a ray vibrating perpendicular to the axis of pressure and only 0.00020 for a ray vibrating in the direction of the thrust.

SUMMARY

Glass when stressed becomes doubly refracting as shown by its behavior in polarized light. This principle has often been made use of in the detection and measurement of strain in glass, but little has been known of the quantitative relation between stress and birefringence. In this paper we have presented the results obtained by loading blocks of glass in a testing machine and measuring the concomitant birefringence. For all of the glasses which we studied except the heaviest flint, a thrust of one kg. per sq. cm. produces a birefringence of 2 to 3 $\times$ 10^{-7}; or, in other words, a path-difference of 2 to 3 $\mu\mu$ per cm. thickness of glass.

Our results show satisfactory agreement with those of Pockels for the flint glasses.

ZOOGEOGRAPHY.—*Discontinuous distribution among the echinoderms.* AUSTIN H. CLARK, U. S. National Museum.

While discontinuous distribution among terrestrial and fresh-water animals has received a considerable amount of attention, the same phenomenon among marine types has not been so widely noticed.

The following apparently anomalous ranges are occupied by the genera of brittle-stars, starfishes and urchins listed; there are no similar cases among the crinoids; and the holothurians, on account of the relatively unsatisfactory state of our present knowledge, have been omitted.

1. Warmer parts of the eastern and western Atlantic; Mexico to Chile: *Narcissia, Arbacia.*

2. Both coasts of tropical America: *Encope, Mellita.*

3. Caribbean Sea and the western coast of Central America: *Hemipholis*, *Ophiocryptus*, *Ophiozona*.

4. Caribbean Sea and the Galápagos Islands (probably in reality the same as the preceding): *Sigsbeia*.

5. Peru to southern California (some only in part): *Astrocaneum*, *Diopederma*, *Gymnophiura*, *Platasterias*, *Nidorellia*, *Amphiaster*, *Paulia* (Galápagos Islands also), *Pharia*, *Phataria*, *Gaenocentrotus* (Galápagos Islands also), *Tetrapygus*.

6. Caribbean Sea and eastern Atlantic, the Hawaiian Islands, southern Japan and the Kei Islands: *Caenopedina*.

7. Western coast of Mexico, the Hawaiian Islands, Australia, Tasmania, Lord Howe Island, the Mediterranean Sea and the adjacent parts of the Atlantic: *Centrostephanus*.

8. Southern and Lower California, southern Japan and southern Australia: *Heliocidaris*.

9. Caribbean Sea and the Hawaiian Islands: *Podocidaris*.

10. Caribbean Sea and southern Australia: *Ophioprium*.

11. Southern California and New Zealand: *Ophiopteris*.

In view of the past intercommunication between the Caribbean Sea and the Pacific the similarity of certain elements of the Caribbean fauna and of that of the western coast of tropical America is not surprising; the latter, however, includes a very considerable number of genera which occur nowhere else, together with a few species of characteristic Indo-Malayan types, such as *Mithrodia*, *Acanthaster*, *Anthenea*, *Leiaster*, *Astropyga*, etc., which are not represented in the Caribbean Sea.

A significantly large number of genera, including well-known and conspicuous littoral types, inhabit a more or less extensive portion of the following anomalous range: Mediterranean Sea, Caribbean Sea, southern Australia and New Zealand, southern Japan, the Hawaiian Islands, and the western coast of tropical America.

This discontinuous range, though indicated by very diverse types and only in part by each, nevertheless must be considered a zoögeographic unit. Its outstanding feature is the fact that it represents the extreme outer limits of a tropical and subtropical faunal region the center of which is the Indo-Malayan region.

The types inhabiting it, that is to say, occurring only on the extreme periphery of the Indo-Pacific faunal area (of which the Mediterranean Sea was at one time a part), may be considered, therefore, as relics of a previous fauna at one time characteristic of the central Indo-Malayan region, from which they have now been extirpated through the competition of younger and more efficient types.

The same facts are brought out equally well in many other groups of marine animals, and are also reflected in a modified way in the terrestrial faunas.

In the faunas of the colder seas all intergradations are found between types which are quite unique and types differing little or not at all from others in the Indo-Malayan region, and this intergradation is complete enough so that we are justified in considering the fauna of the colder waters as similarly ultimately derived from the (past or present) fauna of the East Indian region largely through the intermediary of deep water forms. Some of these genera of the colder waters, as *Astriclypeus* and *Glyptocidaris*, are extraordinarily restricted in their distribution and rare, while others are abundant and widely spread.

ABSTRACTS

Authors of scientific papers are requested to see that abstracts, preferably prepared and signed by themselves, are forwarded promptly to the editors. The abstracts should conform in length and general style to those appearing in this issue

GEODESY.—*General instructions for precise and secondary traverse.* U. S. Coast and Geodetic Survey, Special Publ. 58 (serial 111). Pp. 48, figs. 5. 1919.

The instructions are designed for the highest class of traverse, equal in accuracy to primary triangulation, and for secondary traverse comparable in accuracy with secondary triangulation. R. L. F.

APPARATUS.—*A furnace temperature regulator.* WALTER P. WHITE and LEASON H. ADAMS. Phys. Rev. 14: 44–48. July, 1919.

By making the heating coil of an electric furnace one arm of a wheatstone bridge, and combining this with a galvanometer regulator, thus keeping constant the resistance of the coil, we can, regardless of variations in the current-supply, and with no attention, maintain constant the temperature of furnaces not too directly influenced by the temperature of the room, or where the surrounding air is kept constant. The power available in this regulator is relatively very great; nothing has to be inserted within the furnace cavity, and the lag is practically nothing; the regulator is often nearly at its best under conditions most unfavorable to other regulators. It has held a small furnace for hours constant to 0.1° at temperatures from 500° to 1400°C.

W. P. W.

PHYSICS.—*Temperature distribution in solids during heating or cooling.* E. D. WILLIAMSON and L. H. ADAMS. Phys. Rev. 14: 99–114. August, 1919. (Geophysical Lab. Papers on Optical Glass, No. 11.)

In deciding on the best methods of carrying out various operations in the manufacture of optical glass, it was found necessary to have some idea of the temperature gradients in the pieces during heat treatment.

While great precision in absolute magnitudes is generally of minor importance in such cases, the only way to gain insight into the question of the variation of the temperature differences with the shape and dimensions of the blocks and the method of heating is actually to work out numerical cases.

Equations have been derived for the temperature distribution in solids of several typical shapes, the solids being heated or cooled according to one of two methods, *viz.*, the surface of the body (1) is continuously heated (or cooled) at a uniform rate; or (2) experiences a sudden change to a higher or lower constant temperature. With these equations a number of calculations have been made and the results of the computations are presented in tabular form and, in certain cases, are also shown graphically. By the use of these tables and graphs it is a comparatively simple matter to determine the temperatures within solids of a large variety of shapes when, as is commonly the case, they are heated or cooled according to one of the methods mentioned above.

The equations given are in convenient form for calculation and for showing a number of interesting qualitative relations between the temperature gradients in various solids, and they will probably prove useful in connection with the determination of specific heat and thermal conductivity by dynamic methods.

While the main interest at the time was in the application to glass manufacture, the equations are perfectly general, as are also the qualitative deductions made. E. D. W.

PHYSICS.—*Silicate specific heats. Second series.* WALTER P. WHITE. Amer. Journ. Sci. 47: 1–43. Jan., 1919.

Specific heats of various forms of silica and silicates were determined for upper temperatures from 100° to 1400°. The method was by dropping from furnaces into calorimeters. Two new methods are described for determining true or atomic heats from interval heats. On the whole, the general temperature variation of the specific heats is one depending mainly on the value of ν, the atomic vibration period, for oxygen in combination. Several forms of silica, whose expansion is very small, and which therefore practically give values of specific heat at constant volume, C_v, show that C_v for high temperatures appears to exceed the theoretical value 5.96. Glasses show, in the main, a specific heat only slightly above the corresponding crystal forms, but with a tendency to increase at some rather high temperature. In several sets of polymorphic forms with sluggish inversions there were differences of about

2 per cent between the two forms, but none of these forms showed any variation in specific heat near the inversion temperature. In quartz, below the α-β inversion at 575°, the heat absorption is greater than can be accounted for even by the abnormal expansion. If such absorption, unusual change of volume, and change of crystal properties are each or all together the sign of a change of state, then quartz undergoes a gradual change of state over an interval of 400° below what is commonly called its α-β inversion. Quartz and probably other forms of silica exhibit what appear to be two kinds of inversion, due to different mechanisms. Some of these facts militate against certain hypotheses which make polymorphism the resultant of polymeric or isomeric changes in the solid. W. P. W.

INORGANIC CHEMISTRY.—*The hydrated ferric oxides.* EUGEN POSNJAK and H. E. MERWIN. Amer. Journ. Sci. 47: 311–348. May, 1919.

Microscopic and chemical studies show that no series of hydrates of ferric oxide exists among the natural minerals. The only existing hydrate is ferric oxide monohydrate. This substance occurs in nature in two polymorphic forms—goethite and lepidocrocite—and in an "amorphous" condition—limonite. The two crystallized forms are contrasted as follows:

Goethite.—Orthorhombic, $a : b : c = 0.91 : 1 : 0.602$; density (grams per cc.) 4.28 ± 0.01; $\alpha = 2.26$, $\beta = 2.394$, $\gamma = 2.400$; streak, dull orange-yellow; pleochroism faint. When crystallized in dense aggregates of thin blades and fibers inclosing much adsorbed and capillary water, it has commonly been called limonite; however, sufficient proof is now given to show that such crystallized material is really goethite.

Lepidocrocite.—Orthorhombic, $a : b : c = 0.43 : 1 : 0.64$; density, 4.09 ± 0.04; $\alpha = 1.94$, $\beta = 2.20$, $\gamma = 2.51$; streak, dull orange; pleochroism very strong.

The name *limonite* is retained for material which appears to be essentially isotropic ferric oxide monohydrate with adsorbed and capillary water. However, this substance should not be considered a distinct form of ferric oxide monohydrate, as the real nature of such "amorphous" substances is still uncertain.

The fibrous mineral *turgite* is variable in composition, and considerable evidence is given that it probably represents solid solutions of goethite with hematite, together with inclosed and adsorbed water.

The genetic conditions of the hydrated ferric oxides and the stability relation of the two monohydrates are unknown.

No definitely crystallized synthetic hydrated ferric oxide has up to the present been prepared. However, it seems certain that only two distinct types of "amorphous" hydrated ferric oxide exist, one yellow and the other reddish brown. The yellow is apparently essentially ferric-oxide monohydrate, while the reddish brown substance may hold its water in either a dissolved or an adsorbed condition (or both). Thus the synthetic and the natural hydrated ferric oxides exhibit, chemically, great similarity. H. E. M.

INORGANIC CHEMISTRY.—*The ternary system CaO–MgO–SiO₂.* J. B. FERGUSON and H. E. MERWIN. Proc. Nat. Acad. Sci. 5: 16–18. 1919. (Preliminary.) Amer. Journ. Sci. 48: 81–123. Aug., 1919.

The crystalline phases which are definite compounds and which appear as primary phases are as follows: Lime; magnesia; silica (tridymite and cristobalite); α-$CaO.SiO_2$ (pseudowollastonite); $3CaO.2SiO_2$; α- and β-$2CaO.SiO_2$; $MgO SiO_2$ (clino-enstatite); $2MgO.SiO_2$ (forsterite); $CaO.MgO.2SiO_2$ (diopside); $5CaO.2MgO.6SiO_2$; and $2CaO.MgO.2SiO_2$. The melting point of $2CaO.MgO.2SiO_2$ is $1458° \pm 5°C$. and the decomposition temperature of $5CaO.2MgO.6SiO_2$ is $1365° \pm 5°C$. In addition to these, crystals representing several solid solutions also appear as primary phases. The solid solutions are: 1. A complete series with clino-enstatite and diopside as end members, generally known as pyroxenes. 2. The pseudowollastonite solid solutions. 3. The wollastonite solid solutions. 4. The $5CaO.2MgO.6SiO_2$ solid solutions. 5. Certain members of the monticellite ($CaO.MgO.$-SiO_2) solid solutions. Monticellite itself probably decomposes at too low a temperature to ever occur as a primary phase.

The temperature-concentration relations of the liquids which may be in equilibrium with each of these phases have been thoroughly investigated where necessary, by means of the quenching method, and the results obtained have been correlated with the existing data on the remainder of the ternary system. The compounds $5CaO.2MgO.6SiO_2$ and $2CaO.MgO.2SiO_2$ (akermanite) have not been prepared previously. Attempts to prepare a compound of the formula $8CaO.4MgO.9SiO_2$ (Schaller's akermanite) gave negative results. The monticellite solid solutions and the compound akermanite are discussed at length but the wollastonite and the $5CaO.2MgO.6SiO_2$ solid solutions are only briefly mentioned as they are made the subject of a subsequent paper.

Experiments were made on the tridymite-cristobalite inversion temperature, which was found for this system to be below 1500°C., in approximate agreement with Fenner's original value of 1470°.

J. B. F.

INORGANIC CHEMISTRY.—*Wollastonite* ($CaO.SiO_2$) *and related solid solutions in the ternary system lime–magnesia–silica.* J. B. Ferguson and H. E. Merwin. Amer. Journ. Sci. 48: 165–189. September, 1919.

The study of the ternary system $CaO–MgO–SiO_2$ brought to light many perplexing liquidus relations for which there was no adequate explanation. An investigation of the solidus relations was therefore started in order to clear up the doubtful points, and the results of this investigation are given in this paper. The salient features of these results are: (1) A confirmation of the earlier work in regard to the wollastonite-diopside solid solutions, wollastonite taking up a maximum of 17 per cent of diopside. (2) The existence of solid solutions of pseudowollastonite and diopside containing as a maximum about 16 per cent of diopside. (3) The finding of the new compound, $5CaO.2MgO.6SiO_2$. (4) The existence of solid solutions of akermanite (or perhaps of an unstable compound, $3CaO.MgO.3SiO_2$) in wollastonite and pseudowollastonite. The wollastonite solutions extend to a composition containing between 60 and 70 per cent of akermanite, while the pseudowollastonite solutions extend to a composition containing about 23 per cent of the same compound. (5) The presence of an area of solid solution which includes the wollastonite-diopside, the wollastonite-akermanite, and the wollastonite-$5CaO.2MgO.6SiO_2$ solid solutions.

In addition to the results just mentioned, which suffice to clear up the liquidus relations in question, as thorough an investigation as the nature of the problem and the available methods of attack would permit was carried out upon the solid solutions of silica and $3CaO.2SiO_2$ in calcium metasilicate and upon the inversion and decomposition temperatures of all the various solid solutions. A general discussion of these results with diagram and models, is given. J. B. F.

ANALYTICAL CHEMISTRY.—*Electrometric titrations, with special reference to the determination of ferrous and ferric iron.* J. C. Hostetter and H. S. Roberts. Journ. Amer. Chem. Soc. 41: 1337–1357. September, 1919.

The advantages of the electrometric method for titrating, oxidizing, and reducing reactions may be summarized as follows: (1) This

method permits the use of potassium dichromate with its numerous advantages. (2) The reduction of the solution with electrometric control eliminates the removal of excess reducing agent, which must be done with the usual methods of reduction. (3) Conditions, such as acidity, need not be controlled, except within very wide limits, and hydrochloric, sulfuric, or hydrofluoric acid, or mixtures of these, may all be used. In contrast to these wide limits, compare the narrow acid limits (1.5 to 2.5 per cent by volume of H_2SO_4) within which the reduction with SO_2 or H_2S must be carried out and the precautions which must be taken in a permanganate titration in the presence of either chlorides or fluorides. (4) The sensitivity and accuracy of the method make possible (*a*) the determination of a few tenths of a milligram of tin, chromium, ferrous or ferric iron, and probably many other elements, in the presence of large quantities of some other element, and (*b*) the determination of blanks involved in some of the ordinary determinations by reducing or oxidizing agents. (5) The time within which a determination can be carried out is greatly shortened. The content of ferrous and ferric iron in a silicate, for instance, can be determined in from 15 to 30 minutes. (6) The precision attainable is comparable to the best of the ordinary volumetric determinations. J. C. H.

ANALYTICAL CHEMISTRY.—*Electrical apparatus for use in electrometric titration*. HOWARD S. ROBERTS. Journ. Amer. Chem. Soc. **41**: 1358–1362. September, 1919.

A description of simplified and inexpensive apparatus for use in the titration of salts by the electrometric method. The potentiometer consists of a sliding rheostat with attached scale. Several forms of galvanometer may be used. H. S. R.

GEOLOGY.—*Upper Cretaceous floras of the eastern gulf region in Tennessee, Mississippi, Alabama and Georgia*. EDWARD WILBER BERRY. U. S. Geol. Survey, Prof. Paper **112**: 7–172. pls. 33, figs. 12. 1919.

Besides describing the floras, the author discusses in detail the distribution, lithologic character, stratigraphic relations, and local sections of the Tuscaloosa, Eutaw, and Ripley formations, and Selma chalk. As the bulk of the flora is from the Tuscaloosa formation and the representation of the Eutaw and Ripley floras is too meager to throw any considerable light upon their correlation or the physical conditions accompanying deposition, this contribution is devoted prin-

cipally to the elucidation of the Tuscaloosa flora, which, as described in the systematic chapter, embraces 151 species. The present treatment is conservative, as a considerable number of additional forms represented in the collections by incomplete material have been left uncharacterized. R. W. STONE.

GEOLOGY.—*Water-power investigations and mining developments in southeastern Alaska.* G. H. CANFIELD, THEODORE CHAPIN, and R. M. OVERBECK. U. S. Geol. Survey Bull. **692-B.** Pp. 94 (43–136), pls. 2. 1919.

Contents:

1. *Water-power investigations in southeastern Alaska.* GEORGE H. CANFIELD.

2. *Mining developments in the Ketchikan district.* THEODORE CHAPIN.

3. *Geology and mineral resources of the west coast of Chichagof Island.* R. M. OVERBECK.

1. Consists of gaging station records.

2. A brief note on mining in Ketchikan district in 1917.

3. The complex geology of the west coast of Chichagof Island is the result largely of extensive intrusion, which has metamorphosed the rocks cut by the intrusive bodies and has complicated their structure. The geology of the island is discussed under the following heads: (1) Undifferentiated metamorphic rocks; (2) graywacke; (3) igneous rocks; (4) development of the topographic features. The rocks of the undifferentiated metamorphic series are sheared conglomerate, limestone, argillite, tuff, flow rock, and intrusive rock, and several types of schist. No determinable fossils were found in these rocks; and although the rocks constituting this series may be of different ages, they are probably older than Jurassic or Lower Cretaceous. The graywacke series consists of graywacke, of some slaty and argillaceous beds, and of a little greenstone. The igneous rocks are both intrusive rocks and flow rocks. Granite, quartz diorite, diorite, alaskite, aplite, hornblende gabbro, norite, greenstone, and possibly some andesite, are the types of rocks represented. Quaternary deposits are practically absent, but the results of the action of the ice are remarkably well shown by the topographic features. Mines and prospects of gold, copper and nickel are described. R. W. STONE.

GEOLOGY.—*Mining and mineral deposits in the Cook Inlet-Susitna region, Alaska.* STEPHEN R. CAPPS, J. B. MERTIE, JR., and G. C. MARTIN. U. S. Geol. Survey, Bull. **692-D.** Pp. 106 (177–282), pls. 3, figs. 4. 1919.

Contents:

1. *Gold lode mining in the Willow Creek district.* STEPHEN R. CAPPS.
2. *Mineral resources of the western Talkeetna Mountains.* STEPHEN R. CAPPS.
3. *Mineral resources of the upper Chulitna region.* STEPHEN R. CAPPS.
4. *Platinum-bearing gold placers of the Kahiltna Valley.* J. B. MERTIE, JR.
5. *Chromite deposits in Alaska.* J. B. MERTIE, JR.
6. *Geologic problems at the Matanuska coal mines.* G. C. MARTIN.

1. Quartz lodes in the Willow Creek district, Alaska, where mining has been done since 1908, have yielded more than $1,600,000 in gold and silver and are still being worked profitably. The character of the deposits and the work done in the district in 1917 are described.

2. The western Talkeetna Mountains have long been considered a promising field for the prospector, but the only productive part of it thus far is the Willow Creek district. The construction of lines of Government railroads to the region has made information concerning the region especially timely and valuable. A sketch map of the region is given and its geography and geology as well as the vegetation, game, and routes of travel, are described.

3. The mineral prospects in the upper Chulitna region lie 15 to 30 miles southwest of Broad Pass and include both gold lodes and gold placers. For several years work has been done on lode claims in this remote region, which will be made more easily accessible by the Government railroads. The bulletin includes a sketch map of the region and a description of its geography, geology, vegetation, and game animals, and details of the claims and prospects.

4. Mr. Mertie gives a geologic sketch map of the Kahiltna Valley, describes its geography and geology, and presents an account of its mineral resources, which includes descriptions of the placers on many creeks. Though gold is the only mineral thus far recovered in commercial quantities the placers have yielded small quantities of other valuable minerals, which include platinum and ores of tin and tungsten.

5. The chromite deposits of present interest in Alaska are at the

southwest end of Kenai Peninsula. A description of the deposit now mined and a map showing its location are given in the bulletin.

6. The results of studies of the strata and of the structure in the Matanuska coal field, Alaska, made in 1917, are reported. The paper includes sections showing the character, relations, and thickness of the beds of rock and coal at many localities, as well as a graphic section showing a tentative correlation of certain coal beds between places specified. G. C. M.

GEOLOGY.—*Sulphur deposits and beach placers of southwestern Alaska.* A. G. MADDREN. U. S. Geol. Survey, Bull. 692-E. Pp. 37 (283–319), pls. 2, figs. 6. 1919.

Sulphur deposits: Sulphur-bearing deposits at three localities in southwestern Alaska—in the crater of Makushin Volcano on Unalaska Island, on Akun Island, and near Stepovak Bay on the Alaska Peninsula, are of the volcanic type termed solfataras—that is, they are surface deposits formed by sublimation from hot sulphurous volcanic vapors. They are situated in the belt of active and quiescent volcanoes that extends throughout the Alaska Peninsula, the Aleutian Islands, and Japan.

Makushin Volcano, about 6,000 feet in altitude, is in the northern part of Unalaska Island, about 12 miles west of Dutch Harbor. The floor of the crater is 300 to 500 feet below the higher crags of the rim, but the floor of the basin is exposed only in an area of 20 to 30 acres, where the sulphur deposits occur. Except in this bare area the basin is occupied by glacial ice and snow. It is evident that the main solfataric area is kept bare by subterranean heat. As a whole the sulphur-bearing deposit is earthy and appears to be composed chiefly of siliceous residual products of rock decomposition that have resulted from the highly corrosive chemical action of the hot solfataric vapors on the basalt. The richer deposits of sulphur occur within 2 feet of the surface, but there is also more or less finely divided sulphur disseminated to a depth of at least 16 feet. The commercial bodies of sulphur in this deposit are clearly surficial. The percentage of sulphur at the surface does not indicate that rich deposits exist at depth, as is usually believed by the optimistic prospector.

The sulphur at Akun Island deposit occurs chiefly in the form of crystalline incrustations one-sixteenth to one-eighth of an inch thick on the walls of narrow crevices and small cavities in the porous earthy surface zone.

The sulphur-bearing rock near Stepovak Bay consists of porous volcanic breccia that contains compact crystalline sulphur in veins one-eighth to one-fourth inch thick.

Beach placers: The rocks of Kodiak Island and the neighboring islands consist chiefly of slates and graywackes, which are cut by numerous but for the most part small intrusive masses, partly granitic. Schists that probably underlie the slates and graywackes are present along the northwestern part of the island, and small areas of poorly consolidated Tertiary sediments are reported to lie along the southeastern flanks of the island. Quaternary sediments that consist of ground moraine overlain by glacial outwash gravels and recessional moraines occupy the floors of all the larger valleys and form a considerable belt of coastal plain along the west coast.

All the gold-placer deposits so far discovered on Kodiak Island are confined to the present ocean beaches and practically no valuable placer concentrations have been found in any of the present stream gravels. The evidence presented by the topographic development of Kodiak Island shows that postglacial wave erosion and concentration along the shores of the island, especially along the shores composed of unconsolidated fluvioglacial sediments, is the most active agency favorable to the formation of placer deposits.

Earthquakes of considerable violence are known to occur frequently in this part of Alaska, and they may accelerate erosion, especially in tracts of unconsolidated sediments such as the coastal plain here considered, where steep escarpments facilitate the delivery of loosened material upon a beach where it may be directly attacked by heavy surf. However, storms of unusual intensity or duration are the chief factors in concentrating the loose beach deposits and forming the temporary segregations of placer sands.

The chief minerals that make up the heavy concentrates of the beach comprise magnetite, pyrite, chromite, gold, and a little platinum.

R. W. Stone.

GEOLOGY.—*Mining in Fairbanks, Ruby, Hot Springs, and Tolstoi Districts, Alaska.* Theodore Chapin and George L. Harrington. U. S. Geol. Survey, Bull. 692-F. Pp. 31 (321–351), pl. 1, fig. 1. 1919.

The Fairbanks district, in the Yukon basin, has produced over $70,000,000 in gold and has been a source of considerable silver, lead, tungsten, and antimony Mr. Chapin gives an account of the opera-

tions at the gold and the silver-lead lodes and at the tungsten deposits in 1917.

A molybdenite-bearing quartz vein on Healy River, Alaska, which has been traced by shallow openings for the length of three claims, is the subject of a brief note.

The Hot Springs district, in Alaska, has produced more than $6,000,000 in placer gold, as well as some silver and tin. Mr. Chapin describes the occurrence of tin ore in the district, and gives an account of the mining operations there in 1917. Stream tin has been found in gold placers in the Ruby district at several places, but not in quantities large enough to pay for mining it except as an accessory to the gold.

The Tolstoi district, Lower Yukon basin, includes an area about 12 miles wide by 20 miles long, which lies on the flanks of Mount Hurst in the basin of Tolstoi River, on the branches of which placers that yield gold and platinum have been worked for several years. The topography, geology, climate, vegetation, and animal life of the district, the producing placers, and the economic factors that affect mining are described by Mr. Harrington. G. C. M.

GEOLOGY.—*Mineral resources of Seward Peninsula, Alaska.* GEORGE L. HARRINGTON. U. S. Geol. Survey, Bull. 692-G. Pp. 48 (353–400), pl. 1. 1919.

Stream tin has been found in many streams in Alaska, and lodes of cassiterite have been prospected and mined at several places in Alaska. An account of the tin deposits and tin mining in Seward Peninsula is given.

The graphite deposits of Seward Peninsula have been known for many years, but gold has so long been the most valuable mineral mined there that other minerals have not been much considered by the miner. The location of the deposits and the work that has been done on them are sketched.

The search for the sources of the placer gold found in the streams of Alaska has been a part of the work of the geologists who have been studying and mapping the topography and geology of the Territory. The author describes the geology and mineral resources of the Kowalik and Koyuk region, stating the means of communication, timber, coal, and sources of water supply, gives detailed descriptions of the gold and platinum placers, and makes suggestions as to the original sources of the metals. G. C. M.

GEOLOGY.—*A reconnaissance of the Pine Creek District, Idaho.* EDWARD L. JONES, JR. U. S. Geol. Survey, Bull. 710-A. Pp. 36, pl. 1. 1919.

The Pine Creek district, Idaho, lies immediately west and south of the Wardner district of the Coeur d'Alene region. The Pine Creek drainage basin is underlain chiefly by sedimentary rocks of Algonkian age, termed the Belt series. These rocks are intruded by small black dikes, mainly along faults. Deposits of well-rounded gravel of Tertiary age cap many of the low hills adjacent to Coeur d'Alene River. Extensive faulting has occurred in the Pine Creek district; all these faults are of the normal type.

The ore deposits of the Pine Creek district are metasomatic fissure veins and fissure fillings, with gradations between the two types. The veins that show metasomatic replacement are best developed in shear zones along major faults; the fissure fillings are best developed along minor faults or in zones of moderate shearing. The veins are chiefly valuable for their zinc, lead, silver, and antimony content, though some contain also gold and copper. These veins are probably best classified on the basis of their dominant metal or mineral content, into zinc-lead, antimony, and siderite veins.

The best examples of the metasomatic fissure veins are those of the zinc-lead type. The most valuable ore is a fine-grained aggregate of sphalerite and galena in which there are commonly fragments of unreplaced wall rocks. Pyrrhotite accompanies the ore and in places is the chief mineral. Chalcopyrite is usually present in small amounts.

The antimony veins differ markedly from the other veins of the district in mineral composition. The principal metallic sulphide is stibnite. Pyrite is a common constituent of these veins, and here and there they contain sphalerite.

Manganiferous siderite veins occur in the southern part of the Pine Creek basin. These veins are simple fissure fillings. No important ore bodies have yet been developed in any of them.

The primary sulphide minerals of the Pine Creek district are galena, sphalerite, pyrite, pyrrhotite, chalcopyrite, tetrahedrite, stibnite, and arsenopyrite. The minerals that resulted from the oxidation of the sulphides are cerusite, malachite, massicot, pyromorphite, and chalcocite.

Mines and prospects are described. R. W. STONE.

GEOLOGY.—*The Farnham anticline, Carbon County, Utah.* FRANK R. CLARK. U. S. Geol. Survey, Bull. 711-A. Pp. 13, pls. 2, fig. 1. 1919.

The Farnham anticline is in the south-central part of Carbon County, Utah. The surface strata involved in the anticline are the Mancos shale, the Dakota sandstone, and the McElmo formation.

The anticline is a small uplift in a broad, gently northward-dipping monocline which was developed in the movement that produced the San Rafael Swell and Uinta Basin folds. It is about 3 miles long by three-quarters of a mile wide. The dip of the rocks affected by the anticline rarely exceeds 10° except adjacent to faults, where it ranges from 25° to 85°. Several faults cut the surface strata of the anticline and trend roughly parallel to the axis of the fold.

The Farnham anticline is structurally favorable for the accumulation of oil and gas, and the nearest exposures of Triassic and Pennsylvanian rocks contain oil seeps. These conditions appear to warrant one or more test holes of this fold, and locations for test holes are suggested. This paper concludes with a review of oil and gas prospecting in Utah.

R. W. STONE.

GEOLOGY.—*Oil shale in western Montana, southeastern Idaho, and adjacent parts of Wyoming and Utah.* D. DALE CONDIT. U. S. Geol. Survey, Bull. 711-B. Pp. 26 (15–40), pl. 1, figs. 2. 1919.

In the Dillon-Dell area, Montana, where the Phosphoria oil shale is at its best, the richest beds of 3 feet or more in thickness yield 25 to 30 gallons of oil to the ton. The phosphate beds associated with the shale are thinner and contain considerably less phosphorus pentoxide than those mined near Montpelier, Idaho, and those known to occur in the Melrose and Garrison fields of Montana. Samples of the shales associated with the high-grade phosphate rock in the southeastern Idaho area yielded on distillation little more than a trace of oil.

R. W. STONE.

ENTOMOLOGY.—*The parasitic aculeata, a study in evolution.* WILLIAM MORTON WHEELER. Proc. Amer. Phil. Soc. 58: 1–49. 1919.

After summarizing the various types of parasitism in the hymenopterous insects known as Aculeata (excepting the Scoliids and Mutillids), and presenting an interesting hypothesis as to how parasitism arose, the author summarizes his conclusions as follows:

1. "We may distinguish two intergrading types of parasitism among insects. One of these is true parasitism and is represented by the lice, fleas, Mallophaga, many Diptera (Oestridae, Pupipara) and some Hemiptera, which live on mammals and birds and do not destroy their hosts. The other is parasitoidism, which is really a refinement of predatism and is eminently characteristic of large sections of the Hymenoptera and Diptera (Tachinidae). It leads sooner or later to the death of the host. The difference between the two types is largely due to differences in the size and vigor of the hosts."

2. "Parasitoids are of two classes, one of which is best represented by the so-called Parasitica among the Hymenoptera and the Tachinidae among the Diptera, which have no genetic relationship with their hosts. The other class of parasitoids is represented by the Aculeates which have sprung directly from their host species (intraspecific parasitoids), though they may subsequently acquire hosts among other species of the same genus or of other genera and may in turn be the ancestors of parasitic species."

3. "The derivation of all the existing Aculeata from primitive insectivorous wasp-like ancestors may account for the retention of a rather uniform pattern of behavior among the parasitic species. The parasites, both among the solitary wasps and the solitary bees, behave in a very similar manner, though the former are reared on insect prey, the latter on pollen and honey.* * * "

4. "The origin of parasitism among the Aculeata may be attributed to urgency of oviposition and temporary or local dearth of the supply of provisions for the offspring."

5. "In all the different forms of parasitism among the Aculeata, there are traces of the primitive predatism or parasitoidism from which it arose, although in some of the social parasites this is represented only by the aggressive or conciliatory intrusion of the recently fecundated female into the host colony.* * * "

6. "Although many cases of parasitism are known to occur among the Aculeata, and although many others will doubtless be discovered in the future, nevertheless the total number must be small in comparison with the thousands of nonparasitic species. Contemplation of such a series as we find among the ants, beginning with *Formica sanguinea*, which is an abundant, vigorous and aggressive species, and ending with *Anergates atratulus*, a small, sporadic, and apparently evanescent species, without workers and with wingless, nymphoid males, suggests that parasitism among the Aculeates tends to such extreme specialization

("degeneration") as to lead to extinction. If we possessed a knowledge of the whole evolution of the Aculeate group, we should probably find that the total number of parasitic species which it produced during the ages was very great, but that the vast majority of them, after reaching the Anergates or a similarly specialized, or degenerate stage, lingered on precariously for a time and then disappeared."

The paper is completed with a list of the literature examined.

S. A. ROHWER.

CERAMIC CHEMISTRY.—*Devitrification of glass.* N. L. BOWEN. Journ. Amer. Ceram. Soc. 2: 261–278. April, 1919. (Geophysical Lab. Papers on Optical Glass, No. 9.)

Devitrification of glass is the result of the tendency of the glass to reach the stable crystalline condition and takes place whenever the glass is held for a sufficiently long period of time within the range of temperature where its crystallizing power is great. The various forms of devitrification in glass are discussed from this point of view and suggestions are made as to the principles that must be borne in mind in deciding upon modifications of procedure or changes in composition that have as their object the avoidance of devitrification. Specific examples of the devitrification of optical glasses are given, together with identification of the crystalline phases separating. N. L. B.

CERAMIC CHEMISTRY.—*The volatilization of iron from optical glass pots by chlorine at high temperatures.* J. C. HOSTETTER, H. S. ROBERTS and J. B. FERGUSON. Journ. Amer. Ceram. Soc. 2: 356–372. May, 1919. (Geophysical Lab. Papers on Optical Glass, No. 12.)

Of all the ordinary impurities found in optical glass, iron exerts the greatest influence on transmission. The iron-content of the glass arises from pots used as containers during melting as well as from the raw materials. The content of iron in the glass and, therefore, its transmission, would be considerably improved if the iron could be removed from the pot-walls before use. Chlorine appeared to be a suitable agent for this purpose, and experiments demonstrated the fact that approximately 80 per cent of the iron could be extracted from the interior of the clay pots and volatilized by the action of chlorine at temperatures easily secured in a pot-arch or glass-melting furnace. Large-scale experiments were carried out and conditions developed for removing more iron from the bottom of the pot, where the most corrosion

takes place, than from the side-walls. Glass melted in these pots showed, in all cases but one, less iron than that made in untreated pots. In the exception noted above, however, more iron was found in the glass made in the treated pot, and it was shown that, although the iron had been volatilized from the pot, more than usual pot corrosion had taken place during melting. The success of the method, then, depends on whether a dense surface can be made in such pots when the iron has been removed, as, for instance, by burning under different conditions from that obtaining during the course of these experiments. With some types of pots the method would undoubtedly be successful, even with the usual burning schedules. The possible application to the removal of iron from grog, clay, and other ceramic products is indicated.

J. C. H.

RADIOTELEGRAPHY.—*Principles of radio transmission and reception with antenna and coil aerials.* J. H. DELLINGER. Proc. Amer. Electr. Eng. 38: 1095–1150. 1919.

Coil aerials are coming to replace the large antennas in radio work. The advantage of the coil aerial as a direction finder, interference preventer, reducer of strays, and submarine aerial, make it important to know how effective such an aerial is as a transmitting and receiving device in comparison with the ordinary antenna. In this article the mathematical theory is presented and, as a result, the answer to this question is obtained. Experiments have verified the conclusions reached, and the formulas which are obtained are a valuable aid in the design of an aerial to fit any kind of radio station.

It is found that the coil aerial is particularly desirable for communication on short wave lengths. A coil aerial is as powerful as an antenna only when its dimensions approach those of the antenna. For other reasons, however, a small coil aerial is in many cases as effective as a large antenna. It is shown that an advantageous type of radio aerial is a condenser consisting of two large metal plates. This type of aerial has many of the advantages of the coil aerial. The fundamental principles of design of aerials are given in the paper. On the basis of this work the actual functioning of any type of radio aerial can be determined either from measurements made upon the aerials or from actual transmission experiments.

J. H. D.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

PHILOSOPHICAL SOCIETY

820TH MEETING

The 820th meeting was held at the Cosmos Club, May 24, 1919, with President HUMPHREYS in the chair and 34 persons present. The minutes of the 819th meeting were read in abstract and approved.

The first paper, by Messrs. H. L. CURTIS and R. C. DUNCAN, on *Measurements of short time intervals*, was presented by Mr. Duncan.

Early in the war, at the request of the Navy Department, the Bureau of Standards undertook the investigation of certain factors which had to do with the firing of the 14-inch Naval guns. It was desired to measure a number of time intervals into which the total firing time of the gun may be divided and also to study the motion of the gun as a function of time. Both of these problems required the measurement of short time intervals with considerable accuracy.

The General Electric oscillograph was chosen as the apparatus for recording the events which were to be studied. A special timing system was installed in the oscillograph, which ruled on the film an equal interval time scale, consisting of sharp lines running across the film. By means of a proper optical system, light from the arc used to illuminate the mirrors of the oscillograph was caused to fall on the film after passing through a narrow slot, which was open only for very short times at regular intervals. This slot was made by fastening a slotted aluminum vane on each prong of a tuning fork and adjusting the vanes so that when the fork is at rest the slots will allow the light to pass through. As the fork vibrates, these slots are opened twice each vibration. A 500-cycle fork is used to rule the film in thousandths of a second, while the 50-cycle fork rules the film in hundredths of a second.

Considerable trouble was experienced in driving the 500-cycle fork at sufficient amplitude. Satisfactory results, however, were finally obtained by driving 500-cycle forks by means of a 100-cycle master fork. In this way the electro-magnets of the 500-cycle forks were energized once every five vibrations and by careful tuning it has been possible to get a double amplitude of nearly 2 mm. This is important, as the sharpness of the timing lines depends upon the amplitude of the fork vibrations. In order to eliminate any possible errors due to the master fork, a relay is so arranged that as the exposure is made the

driving current is broken and the timing forks, therefore, vibrate freely. A similar set-up consisting of 50-cycle forks and a 50-cycle master fork is used to rule slow-moving films into hundredths of a second.

An examination of the timing line records indicates that the lines are not equidistant, every alternate interval being slightly wider than the intervening ones. This is due to the fact that the vanes are not properly adjusted. As it was found almost impossible to adjust them exactly these errors are eliminated by interpolating between every other line. It is only necessary to do this when extreme accuracy is desired.

Further examination of the records indicates that the time exposure is extremely short, certainly not greater than 0.000 01 second. Even when the film is moving at a speed of 1500 cm. per second the lines are quite sharp.

In order to test the accuracy which could be obtained in the determination of time intervals, one film was exposed on each of two oscillographs simultaneously. One recording galvanometer on each oscillograph was put in series with a current interrupted by a tuning fork. By examining the two films, it was possible to identify the individual interruptions. Measurements were then made on both films to determine the time intervals between certain vibration rates of the two circuits. The time intervals measured on the two films varied in every case by less than 0.000 01 second.

It therefore seems that this method makes it possible to measure intervals of thousandths of a second to better than one per cent, while intervals from 0.1 to 0.2 second can be measured with an accuracy of about 0.01 per cent.

The paper was illustrated by lantern slides. It was discussed by Messrs. SILSBEE and BEAL.

The second paper was by Mr. A. F. BEAL, on *Comparison of invar with steel as shown by the rates of high grade watches.*

For watches such as the Bureau of Standards is testing for use as chronometers by the United States Shipping Board, where they are mounted so as to remain horizontal at all times, the compensation for changes of temperature is the only important known cause of variation that is not entirely within the control of the adjuster. Uniformity of rate for different temperatures depends upon the physical constants of the balance wheel and hairspring, and perfect compensation has been unobtainable with the customary steel hairspring and brass-steel balance wheel. If, in the balance wheel, invar be substituted for steel, a combination can be obtained which will show rates that are practically constant over large ranges of temperature.

During 1917 and 1918, the Bureau of Standards tested the watches supplied on two purchase orders placed by the United States Shipping Board with two American manufacturers of high grade watches. Those supplied on one of these orders (for 200 watches) had brass-

steel balance wheels and the watches were constructed from new designs in only a few months. Those submitted on the other order (for 250 watches) had brass-invar balance wheels and had been carefully developed during about five years or more. The mean of the middle temperature errors (difference of daily rate at 20°C. from the mean of the daily rates at 35°C. and 5°C.) for the 200 accepted watches with brass-steel balance wheels was 2.25 seconds, while for the 250 accepted watches with brass-invar balance wheels the mean was 0.24 second, thereby showing that invar will permit much better temperature compensation than will steel.

Following the end of the acceptance tests of these watches they were checked up each week until they were sent to the ships; the mean weekly temperatures were also observed. The rates of 30 watches with brass-invar balance wheels and 32 watches with brass-steel balance wheels were carefully corrected for the observed changes of temperature. Based upon observations for 18 weeks the mean of the probable errors of forecasting the mean daily rate for the ensuing week was 0.277 second for the brass-invar watches and 0.260 second for the brass-steel.

It was noticed that occasionally the watches with brass-invar balance wheels showed sudden permanent changes of rate corresponding to permanent changes in the inertia of the balance wheels. These occasionally amounted to 10 seconds in the mean daily rate. Following a jump of this character, the rate of a watch usually would remain practically constant at its new value. Most of the watches did not show any pronounced changes. In computing the above probable errors, there was not used any watch which showed an important change of rate. These erratic performances were not observed for the watches with brass-steel balance wheels.

The conclusion is that invar, when substituted for steel in balance wheels, will permit practically perfect temperature compensation, and will show good stability of rate; occasionally, however, sudden permanent changes of rate throw a shadow of doubt over the advisability of this substitution. This conclusion is in agreement with statements made by employees of certain watch manufacturers who have experimented on this subject, and with the reports on the stability of invar for other purposes.

The paper was illustrated by lantern slides. It was discussed by Messrs. R. Y. Ferner, C. A. Briggs, and W. P. White.

Adjournment took place at 10.10 and was followed by a social hour.

S. J. Mauchly, *Recording Secretary.*

SCIENTIFIC NOTES AND NEWS

MATTERS OF SCIENTIFIC INTEREST IN CONGRESS[1]

The first of the bills commented upon in this column to become law is H. R. 6810, the National Prohibition Act. At the time of the last report on this bill[2] it was before the Senate Committee on the Judiciary, which reported the bill with numerous amendments on August 18 (Report 151). The bill was debated in the Senate on September 4 and 5, and the section providing for tax-free pure alcohol for scientific purposes was modified in several respects, among which was the substitution of the words "for scientific purposes, or for the use of any hospital" in place of the words "for the use of any scientific university or college of learning, any laboratory for use exclusively in scientific research, or any hospital not conducted for profit."

The amended bill was passed by the Senate on September 5, and as the House disagreed to many of the amendments, was sent to conference on September 9. As modified by the conferees it was passed by the Senate on October 8 and the House on October 10, but was vetoed by the President on October 27 on account of the inclusion of war-time prohibition provisions. The House and Senate promptly re-enacted the bill over the veto and it became Public Law 66 on October 28.

The provision for tax-free alcohol for scientific work, as finally adopted, is as follows:

(Part of Title III, Section 11): "Alcohol may be withdrawn, under regulations, from any industrial plant or bonded warehouse tax free by the United States or any governmental agency thereof, or by the several States and Territories or any municipal subdivision thereof or by the District of Columbia, or for the use of any scientific university or college of learning, any laboratory for use exclusively in scientific research, or for use in any hospital or sanatorium."

The First Deficiency Act for 1920 (H. R. 9205), which was signed by the President on November 4 as Public Law 73, carries appropriations for the Bureau of Standards of $250,000 for industrial research, $25,000 for the study of safety standards, and $50,000 for standardization work on instruments, machinery, and equipment.

A bill "to authorize the President of the United States to arrange and participate in an international conference to consider questions relating to international communication" was introduced in October, in the Senate by Mr. LODGE (S. 3172) and in the House by Mr. ROGERS (H. R. 9822). The House bill was passed on October 22, with one amendment, providing for confirmation of the delegates by the Senate.

[1] Preceding report: This JOURNAL 9: 562. 1919.

[2] This JOURNAL 9: 423. 1919.

It is now before the Senate Committee on Foreign Relations. Among the questions to be considered are problems of wireless wave-lengths and of vessel-to-shore communication.

The Patent Office legislation, before the House Committee on Patents, was divided several weeks ago so that the bills proposing an independent patent and trade-mark department and a court of patent appeals were to be further considered by a subcommittee, while another subcommittee was to consider salaries in the Patent Office.

Dr. C. L. ALSBERG, chief of the Bureau of Chemistry, appeared in October before the Senate Committee on Agriculture and Forestry, to testify concerning the properties and uses of saccharin. The Committee had under consideration S. Res. 209, authorizing an investigation and report on "the present status of saccharin under departmental regulations and the feasibility of its wider use in the United States for the relief of the present sugar shortage."

Hearings were held on Mr. MYERS' anti-vivisection bill[3] (S. 1258) on November 1–4, before a subcommittee of the Senate Committee on the Judiciary. Representatives of various anti-vivisection organizations spoke in favor of the bill. The bill was opposed by Drs. W. H. WELCH, SIMON FLEXNER, C. W. STILES, W. B. CANNON, REID HUNT, J. B. NICHOLS, and many others, representing the medical profession of the District of Columbia and the country at large, as well as the Army and Navy and the Federal bureaus. "A public meeting to arouse feeling favorable to the bill" was held at the Public Library on October 31.

The need of research on methods for the fixation of atmospheric nitrogen is recognized in H. R. 10329 (Mr. KAHN, November 1): "A bill to provide further for the national defense; to establish a self-sustaining Federal agency for the manufacture, production, and development of the products of atmospheric nitrogen for military, experimental, and other purposes; to provide research laboratories and experimental plants for the development of fixed-nitrogen production; and for other purposes."

The bill provides for the organization of the "United States Fixed Nitrogen Corporation," with a preferred capital stock of $12,500,000, to be subscribed by the United States. Control is placed in a board of directors appointed by the Secretary of War. The Corporation is given power to acquire and operate U. S. Nitrate Plants Nos. 1 and 2 (at Sheffield and Muscle Shoals, Alabama) together with accessory plants, including the fixed nitrogen research laboratory now located at the American University in Washington; and to act as agent of the President in completing and operating the hydroelectric power plant at Muscle Shoals, as specified in the National Defense Act of June 3, 1916, but free from the limitations and restrictions imposed by that act. The bill was referred to the Committee on Military Affairs.

[3] This JOURNAL 9: 422. 1919.

NOTES

The property at 1201 Sixteenth Street, now leased and occupied by the National Research Council, has been purchased by the National Educational Association.

The Governor of the Territory of Hawaii has requested the Geological Survey to make a geological examination of the territory with reference to its ground-water resources. Field work will probably be started in January by O. E. MEINZER, W. O. CLARK, and L. F. NOBLE.

The Coast and Geodetic steamer *Hydrographer*, while surveying the Florida Reefs, was caught in the hurricane of September 9. The cables fouled those of the *Tuscarora*, and, in order to save both vessels, the officers and men of the *Hydrographer* had to be transferred to the *Tuscarora;* the cables were then slipped by mate STRAUBE and the *Hydrographer* was blown across the channel on to the shoals. The vessel was floated later and hauled out at Key West for examination. The Secretary of Commerce has sent a letter to Commander G. C. MATTISON and the men of the *Hydrographer*, commending their skill in salvaging the vessel without outside assistance.

Dr. HORACE G. BYERS, formerly of the University of Washington, who was recently appointed chemist in charge of soil investigations in the Bureau of Soils, has accepted the position of head of the department of chemistry at Cooper Union Institute, New York City.

Mr. W. J. COTTON has resigned from the Color Laboratory of the Bureau of Chemistry to accept a position with the National Aniline and Chemical Company, of Buffalo, New York.

Lieutenant Colonel COERT DUBOIS, District Forester at San Francisco, California, has resigned from the U. S. Forest Service and entered the Consular Service. Colonel DuBois had been a member of the Forest Service since 1900.

Mr. CHESTER G. GILBERT resigned from the Smithsonian Institution on October 1, to accept a position on the staff of Arthur D. Little, Inc., of Cambridge, Massachusetts. This organization has opened a Washington office in the Munsey Building, with Mr. Gilbert in charge.

Mr. F. W. GLADING, of the Bureau of Standards, has resigned to become Industrial Engineer for the Baldwin Locomotive Works, at Philadelphia, Pennsylvania.

Dr. ALES HRDLICKA has been made an honorary member of the Association Liégois pour l'Étude et l'Enseignment des Sciences Anthropologiques, at Liége, Belgium.

Dr. GRINNELL JONES, chemist to the Tariff Commission, has returned to Harvard University but is still retained in an advisory capacity by the Commission.

Dr. D. J. KELLY, first assistant examiner in Division 31 of the Patent Office, died on July 24, 1919. He had been connected with the Patent Office since 1880, and had become an authority on the development of the mineral oil industry.

Dr. G. F. LOUGHLIN, of the Geological Survey, is giving a course of lectures on metalliferous geology at the Massachusetts Institute of Technology, temporarily filling the place of Professor WALDEMAR LINDGREN.

Mr. H. A. NELSON, formerly of the Bureau of Standards, is now with the New Jersey Zinc Company.

Mr. C. G. QUILLIAN, of the U. S. Coast and Geodetic Survey, has laid out a speed-trial course for the use of aircraft in the vicinity of Rockaway Beach, Long Island, at the request of the Navy Department.

Dr. L. W. STEPHENSON, of the Geological Survey, has been granted a six months' leave of absence in the early part of 1920, in order to do stratigraphic work for one of the oil companies in the Tampico oil field, Mexico.

JOURNAL

OF THE

WASHINGTON ACADEMY OF SCIENCES

VOL. 9 DECEMBER 19, 1919 No. 21

ZOOLOGY.—*The Philippine Island landshells of the genus* Platyraphe.[1] PAUL BARTSCH, U. S. National Museum.

Demands for identification of Philippine Island land mollusks have made it necessary to subject a number of groups to a thorough revision. Of these the genus *Platyraphe* seems to have been very poorly understood by writers in the past, and members belonging to this genus have been indiscriminately placed with *Platyraphe* or *Eucyclotus* and *Pseudocyclophorus*. It is not at all surprising that this should have been the case, for the true characters of the group seem to have so far been overlooked, and the superficial characters in many instances resemble characters presented by members of the other two genera.

Members of the genus *Platyraphe* can, however, always be distinguished by the possession of a slender tube in the angle of junction between the outer lip and the parietal wall, on the inside of the aperture; that is, on the inside of the posterior angle of the aperture. This tube begins a little behind the peristome where it is punctured and extends back for a variable distance in different species, terminating in a second puncture. It is evidently used as a breathing siphon when the animal is withdrawn and the shell sealed by the operculum.

Additional new material is arriving so frequently from unexplored regions of the Islands that it does not seem advisable at the present time to publish a monograph upon this group. I am, therefore, retaining the manuscript, which is being added to as the material arrives, and for the present offer a simple key, which it is believed will be of assistance to collectors in identifying their material.

[1] Published by permission of the Secretary of the Smithsonian Institution.

Key to the subgenera of *Platyraphe*

Last opercular turn covered with a solid fused deposit.
Platyraphina new subgenus
Type *Platyraphe* (*Platyraphina*) *catanduanensis* Bartsch
Last opercular turn not covered with a solid fused deposit.
Last opercular turn provided with obliquely placed imbricating scales.......................... *Platyraphida* new subgenus
Type *Platyraphe* (*Platyraphida*) *anthopoma* Möllendorff
Last opercular turn not provided with obliquely placed imbricating scales.
Operculum with the inner edge of the whorls upturned to form a thickened lamella.... *Platyraphe* Möllendorff
Type *Platyraphe* (*Platyraphe*) *coptoloma* Möllendorff
Operculum with the inner edge of the whorls not upturned to form a thickened lamella..*Platyraphella* new subgenus
Type *Platyraphe* (*Platyraphella*) *malibagoana* Bartsch

Key to the species and subspecies of the genus *Platyraphe*

Last opercular turn covered with a solid fused deposit ....*PLATYRAPHINA*
Spiral sculpture present on last turn.
Greater diameter more than 17 mm............*catanduanensis*
Greater diameter less than 9 mm.............*calayanensis*
Spiral sculpture absent on last turn.................*mamillata*
Last opercular turn not covered with a solid fused deposit
Last opercular turn provided with obliquely placed imbricating scales...............................*PLATYRAPHIDA*
Greater diameter more than 14 mm.
Spire depressed..................................*anthopoma*
Spire elevated.....................................*media*
Greater diameter less than 14 mm.
Last nuclear turn with strong axial riblets..............*minor*
Last nuclear turn with feeble axial riblets..........*montalbana*
Last opercular turn not provided with obliquely placed imbricating scales.
Operculum with the inner edge of the whorls upturned to form a thickened lamella.......................*PLATYRAPHE*
Last whorl disjunct at the aperture in adult shells.
Spiral lirations strongly developed on the last whorl.
Peristome decidedly expanded.................*coptoloma*
Peristome not expanded.
Greater diameter more than 6 mm.
Strong spiral lirations at the end of the second whorl 8.............................*princessana*

Strong spiral lirations at the end of the second whorl not 8.
Strong spiral lirations at the end of the second whorl 10. . . . . *busuangensis*
Strong spiral lirations at the end of the second whorl not 10.
Strong spiral lirations at the end of the second whorl 12. . . . . *balabakensis*
Greater diameter less than 6 mm.
Strong spiral lirations at the end of the second whorl 12. . . . . *ulugana*
Strong spiral lirations at the end of the second whorl not 12.
Strong spiral lirations at the end of the second whorl 9.
Greater diameter more than 5 mm. . . . . *leytensis*
Greater diameter less than 5 mm. . . . . *guimarasensis*
Spiral lirations not strongly developed on the last whorl.
Spiral lirations only feebly developed on the last whorl.
Strong spiral lirations at the end of the second whorl 16. . . . . *gradata*
Strong spiral lirations at the end of the second whorl not 16.
Strong spiral lirations at the end of the second whorl 12. . . . . *toledoana*
Strong spiral lirations at the end of the second whorl not 12.
Strong spiral lirations at the end of the second whorl 8. . . . . *businensis*
Strong spiral lirations at the end of the second whorl not 8.
Strong spiral lirations at the end of the second whorl 7. . . . . *negrosensis*
Strong spiral lirations at the end of the second whorl not 7.
Strong spiral lirations at the end of the second whorl 6.
Spiral lirations on the umbilical wall of the last whorl well marked. . . . . *mindanensis*
Spiral lirations on the umbilical wall of the last whorl obsolete. . . . . *buriasensis*
Spiral lirations not feebly developed on the last whorl.
Spiral lirations absent on the last whorl.
Incremental sculpture very strong.
Incremental sculpture consisting of rough riblike elements and fine threads between them. . *surigaoana*

Incremental sculpture consisting of rough riblike elements only.
Greater diameter more than 13 mm.
Inner edge of opercular turns decidedly free, forming a strong lamella.......... *cebuensis*
Inner edge of opercular turns not decidedly free nor forming a strong lamella... *anacampta*
Greater diameter less than 11 mm........ *samarensis*
Incremental sculpture not very strong....... *balukensis*
Last whorl not disjunct at the aperture in adult shells.
Last whorl strongly spirally lirate.
Spiral lirations absent on the anterior third of the whorls.
Greater diameter more than 13 mm........... *mucronata*
Greater diameter less than 13 mm.
Greater diameter more than 10 mm.
Shell finely spirally lirate................ *cagayanica*
Shell coarsely spirally lirate............ *vincentensis*
Greater diameter less than 8 mm.......... *palauiensis*
Spiral lirations not absent on the anterior third of the whorl.
Shell planorboid.
Spiral sculpture present at the summit of the whorls.
Nepionic whorls dark.
Greater diameter more than 10 mm...... *lateplicata*
Greater diameter less than 9 mm......... *stenostoma*
Nepionic whorls light.................. *sibuyanensis*
Spiral sculpture absent at the summit of the whorls.
.... *lubangensis*
Shell not planorboid.
Spiral lirations feeble on the upper surface of the last fourth turn.
Spire depressed.
Spiral lirations on the base of last whorl strong
.... *jordana*
Spiral lirations on the base of last whorl feeble
.... *toppingi*
Spire not depressed but rather elevated.
Axial sculpture very coarse...... *saranganiensis*
Axial sculpture not coarse........... *palmasensis*
Spiral lirations not feeble on the upper surface of the last fourth turn.
Spiral lirations obsolete on the upper surface of the last fourth turn.
Greater diameter more than 10 mm.
Strong spiral lirations on the next to the last whorl 5................... *pagbilaoensis*
Strong spiral lirations on the next to the last whorl not 5.

Strong spiral lirations on the next to the last whorl 6 . . . . *pusilla*
Strong spiral lirations on the next to the last whorl not 6.
Strong spiral lirations on the next to the last whorl 12 . . . . *bonahaoana*
Greater diameter less than 9 mm.
Spiral opercular lamella remarkably broad. *bulusana*
Spiral opercular lamella not remarkably broad.
Spiral lirations at the end of the second whorl 8.
Spiral lirations strong on the first half of the last turn . . . . *balanacana*
Spiral lirations feeble on the first half of the last turn . . . . *ticaoensis*
Spiral lirations at the end of the second turn not 8.
Spiral lirations at the end of the second turn 7 . . . . *masbatensis*
Spiral lirations at the end of the second turn not 7.
Spiral lirations at the end of the second turn 5 . . . . *marinduquensis*
Operculum with the inner edge of the whorls not upturned to form a thickened lamella . . . . *PLATYRAPHELLA*
Umbilicus almost closed.
Strong riblike axial sculpture distantly spaced . . . . *malibagoana*
Strong riblike axial sculpture not distantly spaced . . . . . *globula*
Umbilicus not almost closed.
Umbilicus narrow.
Greater diameter more than 12 mm.
Axial sculpture of base very rough . . . . *plebeia*
Axial sculpture of base not very rough . . . . *camarinana*
Greater diameter less than 10 mm. . . . . *cruzana*
Umbilicus broad.
Spire well elevated.
Greater diameter more than 12 mm. . . . . *expansilabris*
Greater diameter less than 11 mm.
Peristome broadly expanded . . . . *calamianensis*
Peristome not broadly expanded . . . . *bakuitana*
Spire depressed . . . . *substriata*

TABLE 1

ADDITIONAL DATA PERTAINING TO THE FORMS NAMED IN THE ABOVE KEY

Name	No. whorls	Altitude	Greater diameter	Cat. No. U.S.N.M	Locality	Remarks
Platyraphe (Platyraphina) catanduanensis new species	4.3	9.5	17.8	310532	Catanduanes	Type
Platyraphe (Platyraphina) calayanensis new species	4.2	5.3	8.5	310531	Calayan	Type
Platyraphe (Platyraphina) mamillata Möllendorff	4.2	8.2	16.8	303094	Cagayan, Luzon	....
Platyraphe (Platyraphida) anthopoma Möllendorff	4.4	7.5	15.2	184801	Montalban, Luzon	....
Platyraphe (Platyraphida) anthopoma minor Möllendorff	4.3	5.9	13.0	184805	Sibul, Luzon	....
Platyraphe (Platyraphida) anthopoma montalbana new subspecies	4.1	5.2	9.8	195710	Montalban, Luzon	Type
Platyraphe (Platyraphida) anthopoma media Möllendorff	...	....	....	......	Mt. Limutan, Luzon	...
Platyraphe (Platyraphe) coptoloma Möllendorff	4.1	6.3	10.0	201070	Magapig, Cagayan, Luzon	....
Platyraphe (Platyraphe) princessana new species	4.0	5.0	6.9	303099	Pto. Princesa, Palawan	Type
Platyraphe (Platyraphe) busuangensis new species	4.0	5.1	6.7	303089	Busuanga	Type
Platyraphe (Platyraphe) balabakensis new species	4.0	4.7	6.6	310533	Latangun, Balabac	Type
Platyraphe (Platyraphe) ulugana new species	4.2	3.8	5.9	310534	Ulugan, Palawan	Type
Platyraphe (Platyraphe) leytensis new species	4.0	3.6	5.7	303095	Leyte	Type
Platyraphe (Platyraphe) guimarasensis new species	4.1	3.3	4.9	257535	Jordan River, Guimaras	Type
Platyraphe (Platyraphe) gradata Möllendorff	4.4	5.3	7.0	310535	Coron Island	....
Platyraphe (Platyraphe) toledoana new species	4.0	5.2	8.9	310536	Toledo, Cebu	Type
Platyraphe (Platyraphe) businensis new species	4.0	4.5	6.7	258745	Busin Bay, Busin Id.	Type
Platyraphe (Platyraphe) negrosensis new species	3.9	4.4	7.0	195774	Negros Id.	Type
Platyraphe (Platyraphe) mindanensis new species	4.0	4.3	6.3	258738	Lianga Bay, Mindanao	Type
Platyraphe (Platyraphe) buriasensis new species	4.2	4.9	7.0	258741	Pasqual, Burias	Type
Platyraphe (Platyraphe) surigaoana new species	4.3	7.8	13.2	310537	Gigaquit, Mindanao	Type
Platyraphe (Platyraphe) cebuensis new species	4.4	8.9	13.8	184809	Cebu	Type
Platyraphe (Platyraphe) anacampta Möllendorff	4.3	6.8	13.2	184796	Samar	....
Platyraphe (Platyraphe) samarensis new species	4.5	8.1	10.3	258735	Catbalogan, Samar	Type
Platyraphe (Platyraphe) balukensis new species	4.4	6.2	10.0	258751	Balukbaluk Island	Type
Platyraphe (Platyraphe) mucronata Sowerby	4.0	7.8	13.8	184808	Morong, Luzon	....
Platyraphe (Platyraphe) mucronata cagayanica new subspecies	4.0	6.2	11.2	310538	San Vicente, Cagayan, Luzon	Type
Platyraphe (Platyraphe) vincentensis new species	4.1	6.7	11.2	239868	St. Vincente Island	Type
Platyraphe (Platyraphe) palauiensis new species	4.0	6.0	7.4	257537	Palaui Island	Type
Platyraphe (Platyraphe) lateplicata Möllendorff	4.3	5.2	12.1	303082	Tablas Island	....

Name	No. whorls	Altitude	Greater diameter	Cat. No. U.S.N.M.	Locality	Remarks
Platyraphe (Platyraphe) stenostoma Möllendorff	4.0	5 0	8.3	310539	Badajoz, Tablas Island	....
Platyraphe (Platyraphe) sibuyanensis new species	4.1	5.1	9.3	310540	San Fernando, Sibuyan	Type
Platyraphe (Platyraphe) lubangensis new species	4.2	6.2	13.3	258733	Guntung Mt., Lubang	Type
Platyraphe (Platyraphe) jordana new species	4.2	5.2	9.0	257535	Jordan River, Guimaras	Type
Platyraphe (Platyraphe) toppingi new species	4.1	5.2	9.0	258724	Montalban, Luzon	Type
Platyraphe (Platyraphe) saranganiensis new species	4.0	4.8	6.0	256423	Sarangani Island	Type
Platyraphe (Platyraphe) palmasensis new species	3.9	3.9	5.6	258755	Palmas Island	Type
Platyraphe (Platyraphe) pusilla Sowerby	4.1	6.3	10.3	104750	Calamang, Luzon	Cotype
Platyraphe (Platyraphe) pusilla pagbilaoensis new subspecies	4.2	5.8	9.5	310541	Greater Pagbilao Id.	Type
Platyraphe (Platyraphe) pusilla bonahoana new subspecies	4.3	6.8	11.0	195708	Majayjay, Luzon	Type
Platyraphe (Platyraphe) pusilla bulusana new subspecies	4.2	5.2	8.3	310542	Bulusan, Luzon	Type
Platyraphe (Platyraphe) pusilla balanacana new subspecies	4.3	5.1	7.4	303100	Balanacan, Luzon	Type
Platyraphe (Platyraphe) ticaoensis new species	4.3	4.9	7.9	258730	San Miguel Harbor, Ticao	Type
Platyraphe (Platyraphe) masbatensis new species	4.2	5.2	7.7	288748	Cataingan Bay, Masbate	Type
Platyraphe (Platyraphe) marinduquensis new species	4.2	5.9	8.2	258739	Santa Cruz River, Marinduque	Type
Platyraphe (Platyraphella) malibagoana new species	4.5	11.2	10.7	310543	Malibago, Marinduque	Type
Platyraphe (Platyraphella) globula Möllendorff	4.5	11.5	11.1	303091	Luzon	....
Platyraphe (Platyraphella) plebeia Sowerby	4.3	9.7	11.3	104741	Calamang	Cotype
Platyraphe (Platyraphella) plebeia camarinana new subspecies	4 5	11.0	12.6	184806	Camarines, Luzon	Type
Platyraphe (Platyraphella) cruzana new species	4.4	8.9	10.1	257169	Santa Cruz River, Marinduque	Type
Platyraphe (Platyraphella) expansilabris Quadras & Möllendorff	4.5	8.9	13.9	184795	Calamianes, Luzon	....
Platyraphe (Platyraphella) calamianensis new species	4.3	7.8	10.5	184804	Calamianes, Luzon	Type
Platyraphe (Platyraphella) bakuitana new species	4.5	7.8	9.8	310544	Bacuit, Palawan	Type
Platyraphe (Platyraphella) substriata Sowerby	4.1	8.1	13.1	104752	Siquijor	Cotype

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

BIOLOGICAL SOCIETY

599TH MEETING

The 599th regular meeting of the Biological Society of Washington was held in the Assembly Hall of the Cosmos Club on October 18, 1919; called to order at 8.30 p.m. by Vice-President N. HOLLISTER. Thirty-six persons were present.

The following informal communications were presented:

R. W. SHUFELDT: *Exhibition of a young specimen of the wood tortoise* [Clemmys insculpta (*Le Conte*)] secured recently near Bennings, in the District of Columbia. An adult animal was shown for comparison.

WM. PALMER: *Further remarks upon the occurrence of the wood tortoise in the District of Columbia.* Three were reported from the Eastern Branch, one from Plummers Island and another from a marshy spot below Plummers Island. One taken by E. A. PREBLE is now in the District Collection in the National Museum. Three young tortoises of this species were taken from the stomach of a copperhead killed by F. C. CRAIGHEAD.

P. BARTSCH: *Note on the extraordinary tameness of red-breasted nuthatches observed on Mt. Monadnock, New Hampshire.*

The regular program consisted of three communications.

J. S. GUTSELL: *Use of selective screens in studies of oyster larvae.* Mr. Gutsell stated that in studies of larval oysters the Bureau of Fisheries has developed a method of collecting material from a power boat, by means of a pump having a capacity of several gallons a minute. The water thus secured is strained through a screen made of bolting silk. Catches are made in desired localities, placed in suitable containers, and transferred to the laboratory. There the material is passed through a series of six wire-gauze screens of graduated fineness. Much undesired material is removed by the two upper screens that are coarse enough to permit the passage of the oyster larvae. The four remaining screens automatically separate the larvae according to size. Daily studies of the condition of the segregated larvae make it possible to foretell the time when the larvae will set. As the method of collection is quantitative, it is possible also to show where the larvae are drifted by tidal currents and thus to indicate the location of the culch when the proper time arrives. Discussion by Dr. P. BARTSCH followed.

T. S. PALMER: *The discoverer of the toothed birds of Kansas.* Dr. Palmer presented a brief account of the life of Prof. BENJAMIN FRANKLIN MUDGE, former State Geologist of Kansas. Prof. Mudge was born at Orrington, Maine, August 11, 1817, and died at Manhattan, Kansas, Nov. 21, 1879. He came to Kansas about the beginning of the Civil War and was elected State Geologist in 1864. In 1865 he was appointed Professor of Natural Sciences in the State Agricultural College at Manhattan. The last five years of his life were spent in collecting fossils for Prof. O. C. MARSH. During the summer of 1872 Prof. Mudge discovered in the Niobrara beds of the Solomon River the remains of *Ichthyornis dispar*, the first known Cretaceous bird belonging to the group that had teeth in sockets. Four years later at Fort McKinney, Texas, he discovered another species now known as *Ichthyornis lentus*. Only five other species of this genus are now recognized. Prof. Mudge has been described as a "Prince of collectors in the West," and Prof. LESQUEREAUX referred to him in 1871 as "the only truly scientific Geologist west of the Mississippi River." Discussion by J. W. GIDLEY, A. WETMORE and R. W. SHUFELDT followed.

PAUL BARTSCH: *Results in Cerion breeding.* Dr. Bartsch gave an interesting account of experiments in transplanting landshells of the genus *Cerion* from Andros Island in the Bahamas to certain of the Florida Keys. A complete report of the results obtained is now in press and will be published shortly by the Carnegie Institution of Washington. Discussion by H. C. OBERHOLSER and A. WETMORE followed.

ALEXANDER WETMORE, *Recording Secretary pro tem.*

600TH MEETING

The 600th regular meeting of the Biological Society of Washington was held in the Assembly Hall of the Cosmos Club, on November 1, 1919; called to order at 8.10 p.m. by President H. M. SMITH. Fifty-five persons were present.

On recommendation of the council the following were elected to membership: Federated Malay States Museum, Kuala Lumpur, F. M. S.; ELLSWORTH KILLIP, U. S. National Museum.

It was announced that the Council had resolved to tender a vote of thanks to Dr. M. W. LYON, JR., in recognition of his faithful and untiring service as Recording Secretary. This action of the Council was confirmed, and unanimously endorsed by the members present.

Under heading of book notices and general notes the following were communicated:

Dr. H. M. SMITH read an announcement of the unveiling of a monument at Arlington Cemetery, dedicated to the memory of Surgeon General GEORGE MILLER STERNBERG. Gen. Sternberg was President of the Society in 1895 and 1896.

Dr. T. S. PALMER gave notice of the meeting of the American Ornithologists' Union to be held in New York City, November 11 to 13,

inclusive. Dr. Palmer continued with an account of a visit to the New York City Marble Cemetery, where he saw the grave of Dr. DAVID HOSACK. Dr. Hosack, a physician, came to this country from Scotland in 1794, and was instrumental in founding the first Potanical Garden in America, in 1801. Dr. Palmer also announced that recently, in Philadelphia, he had examined a slate over the grave of RAFINESQUE, a site that previously had been unmarked. A suitable tablet has now been installed through the generosity of Messrs. HAND, MERCER and RHOADS.

Dr. C. W. STILES remarked that he had recently seen the grave of E. A. DE SCHWEINITZ in Winston-Salem, North Carolina. Dr. Stiles also announced that recently two manatees (*Trichechus manatus* Linn.) had appeared in Wrightsville Sound, eight miles from Wilmington, N. C., a northern record for this mammal. One of these manatees had been captured and was now on exhibition in Wilmington.

Dr. H. M. SMITH exhibited a recent publication by Dr. R. E. COKER on *The fresh water mussels and the mussel industry of the United States*, published in the bulletin of the Bureau of Fisheries. This paper was excellently illustrated and embodied a most thorough and comprehensive treatise on the subject. Dr. Smith also announced that the steamer *Albatross* had sailed for a cruise along the South Atlantic and Gulf coasts as far as Yucatan. The vessel has been refitted recently with greatly improved apparatus. He also remarked that a recent communication from the agent of the Bureau of Fisheries on St. George Island, Alaska, announced the finding of a dead specimen of the bearded hair seal [*Erignathus barbatus* (Erxleben)] on the beach. The animal measured 93 inches long and appeared to be very old.

Rear Admiral BAIRD exhibited an interesting collection of sea-weeds made thirty years ago by Mrs. BAIRD under the instruction of the elder VERRILL.

The regular program was introduced by the President, Dr. H. M. SMITH, who stated that the present meeting was to be celebrated as the sixth meeting-centenary of the Society. The Biological Society was founded on December 3, 1880, with 44 founders and original members. With 35 of these the speaker had had personal acquaintance. The custom had arisen of setting aside each hundredth meeting of the Society as a commemorative meeting, of which the present was the sixth. The first commemorative meeting (one hundredth meeting) had taken place on November 27, 1886, with Dr. G. BROWN GOODE in the chair, and the fifth on October 19, 1912, at Plummers Island, Maryland, where the Society had been entertained by the Washington Biologists' Field Club.

The Secretary then read a letter from Dr. F. A. LUCAS congratulating the Society upon the occasion and regretting his inability to be present.

Dr. L. O. HOWARD presented a paper entitled *Early days of the Society*. The speaker remarked that in 1880, at the time of the formation of the Biological Society, Boston was considered the scientific center of

the United States and the present-day concentration of scientific workers in Washington was just beginning The first meeting of the Society was held in the home of an entomologist, C. V. RILEY, and the first paper presented was by an ichthyologist, T. H. BEAN. A number of incidents of early days were related, among which was one of the attendance on May 8, 1897, of THEODORE ROOSEVELT, then Assistant Secretary of the Navy. Mr. Roosevelt came to discuss a recent communication by Dr. MERRIAM on the classification of mammals. In closing, Dr. Howard remarked that with the increased number of specialists other bodies had been organized as offshoots from the parent Biological Society and that more of these were coming in the future. All were united, however, in desiring long life and prosperity to the original organization.

The second paper, by Dr. W. H. DALL, was entitled *Reminiscences*. Dr. Dall related that in 1880, in company with T. H. BEAN, he was engaged on a survey of the Alaskan coast in the vessel *Yukon*. He returned to Washington December 31, 1880, and was elected to membership in the Biological Society in January, 1881. The first paper read at a meeting of the Society was by T. H. BEAN on results obtained on this voyage of the *Yukon*, while the second was a presentation of WARD'S *Flora of the District of Columbia*. Other incidents of great interest regarding the early days of the Society were given and the speaker closed by remarking that in his opinion no other society had contributed more toward the advancement of the study of biology in North America.

Dr. T. S. PALMER continued the regular program with a discussion of *The "Proceedings."* The speaker stated that with the current year the *Proceedings of the Biological Society of Washington* will have completed thirty-two volumes that have averaged from one hundred to two hundred pages each. The series now has covered approximately five thousand pages. The first six volumes include addresses made before the Society as well as other matter. The character of the publication was then changed to its present form, a series of brochures comprising short papers and brief notes that deal with new and original contributions in systematic zoology and botany; while one brochure, published at the close of each year, gives a brief synopsis of the regular meetings of the Society. The *Proceedings* have attained such importance that workers in systematic biology find it essential to have the set available for reference.

Discussion of these three papers followed, by H. M. SMITH, M. B. WAITE, W. P. HAY, and DAVID WHITE.

ALEXANDER WETMORE, *Recording Secretary pro tem*

SCIENTIFIC NOTES AND NEWS

Dr. Arthur L. Day, Director of the Geophysical Laboratory, Carnegie Institution of Washington, gave the public lecture at the annual meeting of the trustees of the Institution in Washington, on December 11, 1919. The subject of the lecture was "The War Work of the Geophysical Laboratory."

Rear Admiral James Milton Flint, U. S. N. (Retired), a charter member of the Academy, died at his home in Washington on November 21, 1919, in his eighty-second year. Admiral Flint was born at Hillsborough, New Hampshire, February 7, 1838. He entered the United States Navy as assistant surgeon in 1862, and became medical director of the Navy in 1897, retiring from the service in 1900. During his service with the Navy he was connected at various periods with the U. S. Fish Commission (1884–1887), and with the Smithsonian Institution and National Museum as curator of the Division of Medicine.

Mr. William M. Hall, assistant forester in the Forest Service, resigned on November 24 after twenty years of forestry work. He has become a partner in an enterprise established in Chicago to handle land exchanges.

Major Henry Lee Higginson, one of the trustees of the Carnegie Institution of Washington, died at Boston, Massachusetts, on November 14, 1919, in his eighty-fifth year.

Mr. C. H. Kidwell has been appointed chief of the Quality-of-Water Division of the Water Resources Branch, U. S. Geological Survey, as successor to Mr. A. A. Chambers, resigned.

Dr. Otto Klotz, Director of the Dominion Observatory, Ottawa, has been appointed the representative of Canada on the "Committee on Magnetic Surveys, Charts and Secular Variation" of the International Geodetic and Geophysical Union, recently formed at Brussels.

Mr. E. C. McKelvy, of the Chemical Division of the Bureau of Standards, died at Emergency Hospital on November 29, 1919, in his thirty-sixth year. His death resulted from burns received on the afternoon of November 28, from an explosion of ammonia-condensing apparatus containing petroleum ether cooled by liquid air. Mr. McKelvy was born at Upper Sandusky, Ohio, May 9, 1884. He joined the staff of the Bureau in July, 1907, and was chief of the physico-chemical section of the Chemistry Division at the time of his death. His work for several years past had been on the physical constants of ammonia and other substances used in commercial refrigeration. He was a member of the Academy and one of the associate editors of its Journal; had been secretary of the Chemical Society since 1915; and was a member of the Philosophical Society.

Dr. James Dudley Morgan, one of the early members of the Academy, died at his home at Chevy Chase, Maryland, on November 21, 1919, in his fifty-eighth year. Dr. Morgan was born in Washington July 5, 1862. He spent most of his life in the practice of medicine in Washington, being connected at the same time with the Medical School of George Washington University, Garfield Hospital, and Emergency Hospital. In addition to his memberships in the medical societies, he was a member of the Columbia Historical Society, of which he was president from 1909 to 1916, and became a member of the Academy in 1903.

Dr. Charles D. Walcott, Secretary of the Smithsonian Institution, has been elected an associate member of the Académie des Sciences, Paris.

Mr. Ferdinand Westdahl, hydrographic and geodetic engineer in the Coast and Geodetic Survey, died at San Francisco, California, on October 25, 1919, in his seventy-seventh year. Mr. Westdahl was born at Wisby, Sweden, January 20, 1843. He entered the Survey as an aid in 1867, having been employed previously by the Western Union Telegraph Company, Russian extension, as first mate of the bark *Golden Gate*. At that time he had served on board sailing ships in every capacity from boy to ordinary seaman, able seaman, second and first mate, and sailing master. He was the oldest officer and next to the oldest in point of service in the Survey. His work was chiefly in hydrography along the Pacific Coast, in Alaska, and in the Philippine Islands.

ERRATA

VOLUME IX, 1919

P. 357, line 26: For Humphries read Humphreys
P. 433, line 16: For *nósperos* read *níspcros*
P. 523, line 13: For *an* read *au*
P. 523, line 15: Omit ^{a}‘
P. 523, line 24: For spirant ^{c} read spirant‘
P. 523, line 7 from bottom: For affricative *tc* read affricative *tc*
P. 524, line 6: For *‘ā‘i′^{d}tci‘* read *‘a‘i′^{d}tc‘‘*
P. 524, line 23: For *kekī‘ci‘ta′wipen^{na}‘* read *kekī‘ci‘ta′wipen^{nA}‘*
P. 524, last line footnote [7]: For hear A for *a*, and ^{A}‘ for ^{a}. read hear -A for -*a*, and -^{A}‘ for -^{a}.
P. 535, line 28: For Res. ’76 read Res. 76

VOLUME VIII, 1918

P. 108, line 10: For Medical Corps read Medical Reserve Corps
P. 471, line 6 from bottom: For trajections read trajectories
P. 475, line 16: For plant read plane
P. 478, lines 12 and 15, and p. 479, lines 4, 15 and 16: For sight read site
P. 509, last line: For Section read Service
P. 693, second column, line 4: After 251 add 292, 369,

VOLUME VI, 1916

P. 226, line 2: For 17th read 18th

VOLUME V, 1915

P. 183, last paragraph, line 1: For 16th read 17th
P. 390, line 6: For 40° 1′ read 44° 1′

VOLUME IV, 1914

P. 556, line 7 of table: For prism 110 read 010

VOLUME III, 1913

P. 226, line 5: For p_1, p_2, p_n read $\sqrt{p_1}, \sqrt{p_2}, \sqrt{p_n}$
P. 229, line 1: Add after word "weight:" (or weight $\frac{1}{x_n}$ in (2)).
P. 229, line 4: For by the least square method read from (3)
P. 231, line 1: For x_1, x_2, x_n, read x_1^2, x_2^2, x_n^2
P. 231, line 2: For (5) read (2)′
P. 231, line 3: For (x) read (x^2)

VOLUME II, 1912

P. 178, line 1: For 175 read 176

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An * denotes an abstract of a published paper A † denotes an abstract of a paper presented before the Academy or an affiliated Society. A § indicates an item published under the head Scientific Notes and News

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SUBJECT INDEX

I. A. R. I. 75.

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